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1918

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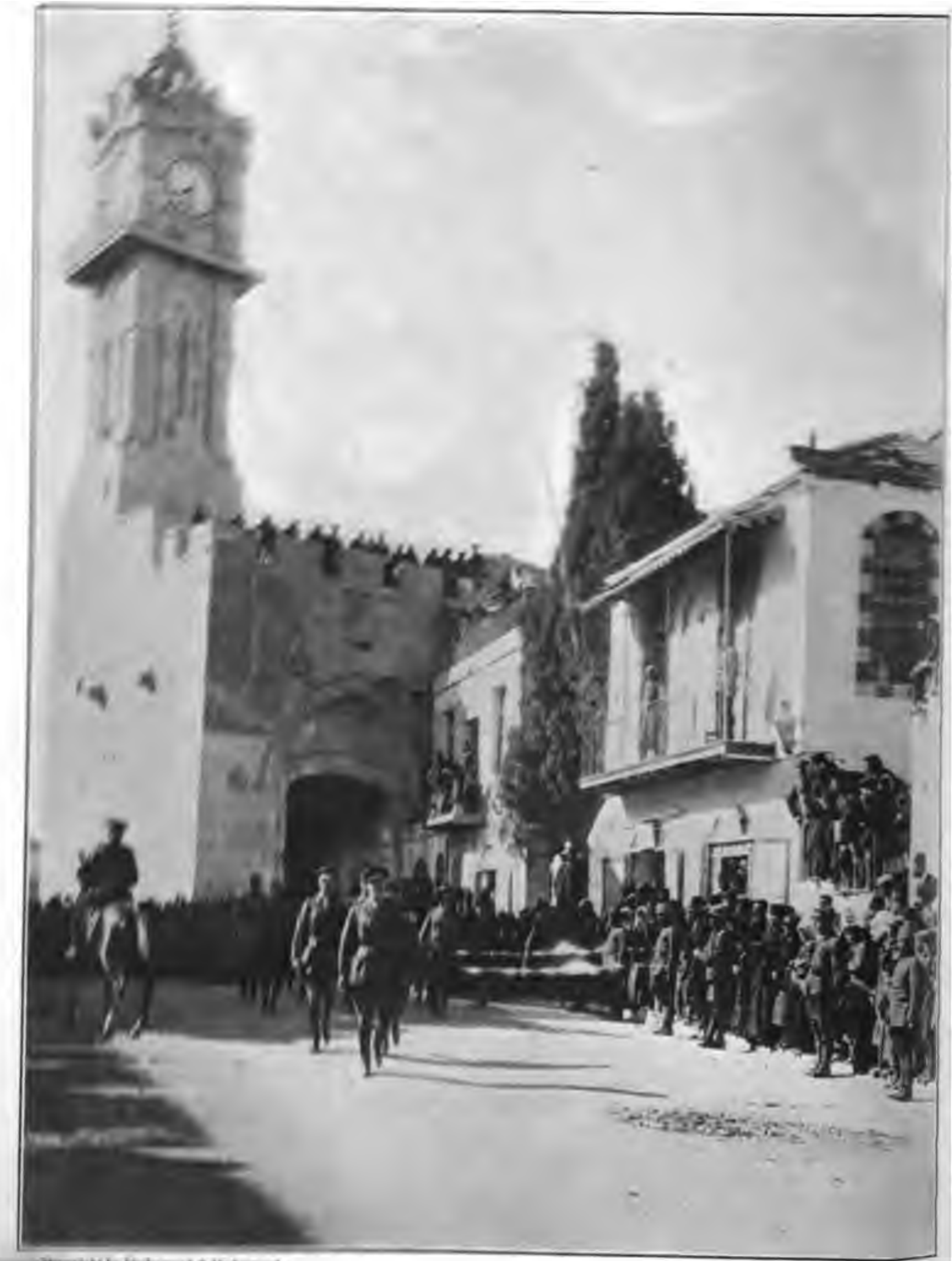

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"GEN. ALLENBY'S ENTRY INTO JERUSALEM" THROUGH THE JAFFA GATE.

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Strategy—Its Principles and Practice[1]

By Major R. E. Wyllie, C. A. C., U. S. Army

Strategy is a very broad field, and to cover it completely in a short paper is only possible by treating it very superficially. In general, Strategy can be divided into Peace and War Strategy, and the latter can be subdivided into (a) that in the area of hostilities and, (b) that at home, comprising the mobilization, etc., of units and resources to support the forces at the front. In this thesis only the strategy of the combatant units in the area of hostilities will be considered.

War is an art not a science. No two identical situations will ever be found, so each must be judged on its own merits. From this it follows that warfare is not governed by immutable rules, no hard and fast procedure can be prescribed which will always be effective, the best that can be done is to examine into the subject and deduce general principles, founded on history and common sense.

The broader the principle, the more nearly will it approach universal application, but it must never be construed as an iron-clad rule which admits of no variation. Just as the successful composer is he who knows when to disregard the ordinary rules of harmony, by introducing dissonances to get the desired effect, so also is the successful strategist he who grasps the opportunity to act, regardless of whether or not it is in conformity with the commonly accepted principles or maxims. The so-called maxims of war not infrequently do much harm, in that they are often construed as being as binding on the strategist as the Koran is on the Mahommedan, or the book of Leviticus on the orthodox Jew; particularly is this the case if they happen to be the utterances of some genius in War. We have, for example, Napoleon's maxim, "Nothing is more rash and contrary to the principles of war than to make a flank march before an enemy in position." It is difficult to imagine a more direct and positive statement, accordingly we should expect to see such a movement invariably lead to disaster, yet it was by executing just such a march that gave victory to the Confederates at Chancellorsville.

---

[1] Written in December, 1916

No rule or even principle can be considered as universal, in war, and there is much temptation to add, not even this one.

Accordingly no attempt will be made in this thesis to derive any but the most general and broadest kind of principles, and these should be treated as guides, not as masters.

War is an armed conflict between nations, in which each seeks to impose its will on the other; it is a continuation of policy by arms instead of by diplomacy, and therefore its aim should be the success of the policy which caused it.

In prosecuting a war two types of armed forces are brought into play, land and naval, and in addition there must be mutual support between them and diplomacy, the latter never ceases to exert an influence, as has been strikingly shown in the present European War.

The successful belligerent imposes his will on the adversary by occupying his territory, with the resultant extinction of his authority and loss of resources. *De facto* sovereignty then passes to the invader, the other still has nominal sovereignty, but is unable to exercise it, and he must accept peace on such terms as the invader may prescribe in order to liberate his territory and regain his authority. Thus the successful belligerent accomplishes the aim of policy.

It is obvious that such an occupation can be made only by land forces, and that the land forces of the enemy must first be overthrown. No effective occupation will be possible while the adversary's army is still a power to be considered, when that has been crushed the hostile territory is open and no resistance is possible. We thus arrive at the well known principle that the true objective of an army is the army of the enemy, not, however, as an end in itself, but because it is the only instrument which can prevent the effective occupation of his territory.

The sea is neutral, it does not belong to any nation, and its occupation by a belligerent (were such possible) can not cripple the natural resources, nor extinguish the authority of the other. The sea is merely a highway, a means of communication, and its value is to be measured solely by the use that can be made of it as a highway for the transportation of troops, for the re-enforcement of the natural resources of the country, and for the requirements of commerce. Therefore the nation that has command of the sea is able to enjoy the benefits of water communication while denying them to the adversary. It is sometimes said that a neutral becomes virtually an ally of the power in command of the sea, because it supplies that nation and not the other belligerent. However, that is an erroneous view, it is the sea-power of the belligerent which produces that state of affairs, and were the neutral to refuse to supply it, it would be virtually making itself the ally of the other, because it would be denying the privileges gained with the command of the sea.

The object of naval warfare is the control of maritime communications, and to acquire such control the naval forces of the adversary must be destroyed or driven off the sea, by doing that the maritime commerce of the one falls, while that of the other is protected. So here again we meet the same principle, that the objective of a naval force is the naval force of the enemy in order to acquire command of the sea, the usual expression for control of maritime communications.

If we compare land and naval warfare as thus set forth, it must be evident that the former is the decisive factor, naval forces alone cannot, except in the most unusual case, exert sufficient pressure to force a belligerent to accept the will of the other, that can only be done by land forces acting in his territory, or within the territory in dispute.

With two continental belligerents having contiguous land frontiers, and surrounded by neutrals from whom supplies can be obtained over land, sea-power has a very small, even negligible, effect on the struggle, the issue will be decided entirely on land. When the two are separated by neutrals, or by water, the latter constitutes the only way by which the land forces can be brought together (assuming that neutrality is not violated) and here will be noted the value of maritime communications. The nation which secures command of them is able to transport troops against his adversary, while his own territory is kept free from invasion. Land forces are the decisive factor, but the navy enables the land forces to be used, and thereby becomes an indispensable aid.

Assume a war between two countries separated by the sea, one having no army and the other no navy, and it is evident that neither one can really harm the other, unless the power with no navy is dependent on overseas commerce for sustenance, in which case the loss of maritime communications will be decisive, but it is only in such a situation that land forces are unnecessary. Great Britain, as an example, is absolutely dependent on sea-borne imports for its daily bread, and should it lose control of the sea, no invasion would be necessary, the pressure of starvation alone would be sufficient.

From a strictly geographical viewpoint the United States is a continental power, but the military aspect is different. We have two immediate neighbors, Canada and Mexico, and, with all our weakness, we are certainly so superior in a military sense to those countries, that we need fear no real invasion from either, except by British troops through Canada, and this requires overseas expeditions across the Atlantic. If we take the offensive against Mexico, our best line of advance, owing to the nature of the terrain in northern Mexico, is that used by Scott seventy years ago, from Vera Cruz against the City of Mexico, and this again requires overseas expeditions. All other countries are separated from us by water, so we see that any war in which we could engage must be of the amphibious type, that is, a combination of sea and land power, with joint army and navy expeditions.

In a military sense we are an insular, rather than a continental power, and that type of warfare based primarily on land forces, frequently called continental warfare, does not apply to our situation. A national strategy for this country should contemplate amphibious operations as the basis, land forces alone are of no value to us, they must be used in conjunction with the Navy, whether for offense or defense.

For this reason we should be careful not to let ourselves be carried away by the theories and practice of those nations of the distinctly continental type, for they necessarily reflect a form of strategy based on an entirely different viewpoint. The Russo-Japanese War was full of joint operations, in fact the whole war might well be considered as an amphibious campaign, so closely linked were the operations of the two services, yet in the Official German General Staff account of that war, land and naval operations were considered separately, as though they pertained to entirely different subjects, and very rarely is the effect of one on the other given full weight. The same remark applies to the work, "The Japanese in Manchuria," by the French General, Cordornier. This is not unnatural, nor does it imply a criticism of those works, since both Germans and French were naturally desirous of learning the lessons which would be applicable to them, that is, to continental warfare, but we should bear that feature in mind, as our proper strategy is of the amphibious rather than the continental type, and in operations of that character the land and sea forces are correlative, neither one can be considered without the other.

Von der Goltz says "Whoever writes on strategy or tactics, ought not, in his theory, to neglect the point of view of his own people. He should give us a national strategy, a national tactics." This is taken as the motto for this thesis, the principles to be derived, and the lessons to be learned, will be discussed mainly on the basis of amphibious warfare.

Our present policy indicates that we shall always be in the front rank of naval powers, but it is also most unlikely that we shall ever possess a land force in time of peace at all comparable with that of the great powers. From this it follows that, in the event of war with such a nation, we must gain time in order to prepare the necessary army; this means that we must act on the strategic defensive until we have sufficient land forces to take the offensive, since, as we have seen, it is only on land that decisive results are possible.

It is not a question of choice in this case, there is no point in arguing on the relative merits of the offensive and the defensive, circumstances will force it on us, we should therefore make the best of the situation, and endeavor to neutralize, as far as possible, the superior land forces opposed to us. On the sea we may be either inferior or superior, consequently our naval strategy may be either offensive or defensive.

It therefore appears that our national strategy must be, in the main, defensive in character, and we should search for methods by which time can be gained for our land forces, and especially how we can utilize our sea-power to that end. Above all we must not sneer at the defensive, as that is our only chance of salvation.

There are two main principles which guide all warfare, whether on sea or land, these we will call concentration and the initiative. *Concentration* consists in so disposing your forces that you may be superior to the enemy at the critical point and moment. A belligerent secures the *initiative* when he compels the enemy to conform to his movements, to accept battle on his own terms, and that means when his concentration is completed so that he is superior at the critical point and moment.

It is therefore evident that the value of the initiative is that it enables the belligerent securing it to take advantage of concentration, and *strategy* is the art by which a belligerent brings about this condition of affairs.

The initiative must not be confounded with the offensive, they are by no means synonymous terms. It is of course true that decisive results are obtained only by the offensive, but it is also true that a strong defense is frequently the best kind of preparation for a future offense. A passive defense can rarely, if ever, be justified, but if it is taken up for the purpose of gaining time, and if the force is inspired by an animus pugnandi which will bring it forward when it is superior to the enemy, it conforms to the principle of concentration, and is therefore strategically sound. Corbett calls defense the "strongest" form of warfare, this seems to be an unfortunate expression, although his meaning is clear, that a stronger force is required to act successfully on the offensive than on the defensive, and of this there can be no doubt. The maxim "attack is the best defense," is open to the objection that can be urged against all such sayings, that it expresses a half-truth only, in some situations it is true, in others false. For example, if the enemy is too weak to take the offensive successfully, it is evidently better to force him to undertake such an operation, than to do it yourself. This is a situation in which we can very easily be placed, and it is imperative that we retain the defensive until properly prepared for decisive results. If one belligerent can succeed in making the other attack, when that other is not properly prepared to do so, the former has gained the initiative, although acting on the defensive, since he has forced his antagonist to give battle under unfavorable conditions. Let us cite an example from history to show this condition.

In 1759, during the Seven Year's War, a joint expedition consisting of 8000 troops under General James Wolfe, with a naval escort under Admiral Saunders, proceeded from Louisbourg against Quebec, the most important city of French Canada, arriving at Isle d'Orleans on June 26.

General Montcalm, commanding the French, had 16,000 troops, the great majority being Canadian militia of poor quality. Almost all Wolfe's troops were regulars, and many of them veterans from European fighting. The French also had a few naval vessels, which were soon driven up the St. Lawrence and played no further part in the campaign.

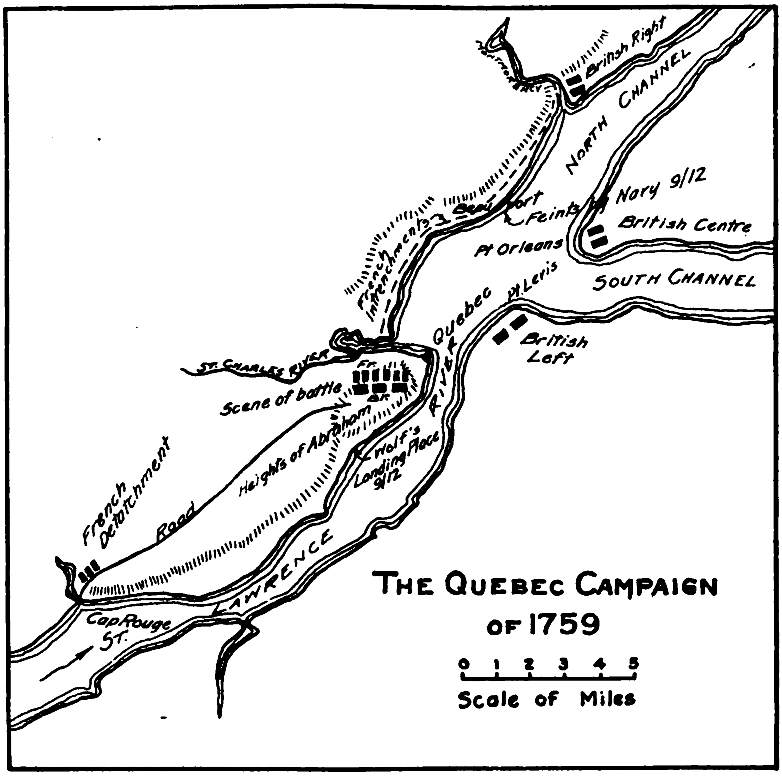

FIG. 1. 2156

Montcalm took up an intrenched position along the left bank (Quebec side) of the river[1], from the city for a distance of nine miles down the St. Lawrence, the left flank resting on the Montmorenci River, which was fordable at one place at low tide only. This was an exceedingly strong position and it covered the most favorable point for the British to attack; the Heights of Abraham, on which Quebec is situated, being difficult to scale from the other side.

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[1] See Fig. 1.

Wolfe's force was much superior in training and morale, but it was outnumbered by 100 per cent and the French were in a strongly intrenched position, where their inferior troops would show to the best advantage. Under these circumstances Wolfe doubted his ability to carry the place by assault; on the other hand if Montcalm should attack, Wolfe's inferiority in numbers could be offset by intrenchments, and the poor quality of the French troops would show up strongly when attacking. By a strong counter-offensive he might then succeed in carrying the French works. In other words he saw that Montcalm was not strong enough to take the offensive, therefore his (Wolfe's) best chance was to force such an action on his enemy.

He accordingly divided his force into three detachments, one remained in the center at Pointe d'Orleans; a second took position just north of the Montmorenci, where it threatened Montcalm's left flank; the third went to Pointe Lèvis, opposite Quebec. Four and a half miles of water separated the center from the right, and three and a half separated the center from the left. He thus hoped to induce Montcalm to strike one of those detachments.

But the Frenchman was not to be enticed, he knew the inferiority of his own troops, and that their best sphere of activity was behind intrenchments; he also knew that nature would fight for him in the winter, that the St. Lawrence would be frozen over by November 1, and that the British must get the place by that time or retire; and finally he was probably not deceived by the appearance of weakness in Wolfe's dispositions. Although separated by water the British had the advantage of water transportation, they were in command of the river below Quebec, and, as subsequent events proved, Wolfe was able to concentrate at any point quicker than could Montcalm, notwithstanding the intervening stretches of water, so the French remained in their trenches, and all Wolfe's arts were unavailing to lure him out. He even made an attack against the French left, by the Montmorenci ford, and by a landing party from Pointe d'Orleans across the St. Lawrence, hoping that Montclam would be induced to make a counter-offensive, but in vain, the landing was not effected, and Montcalm was satisfied with having repulsed the assault.

Here was unquestionably a case where the defense was the true strategic rôle for each, and the initiative would be possessed by the one who could compel the other to attack, and so far it lay with Montcalm.

The operations that ensued cannot be detailed here, suffice it to say that by raiding the French line of communications with Montreal at various points, extending as far as forty-five miles above Quebec, Wolfe compelled his opponent to send a considerable force in that direction in order to keep open his supply line. This dispersion so weakened Montcalm's garrison in the city that Wolfe, by a remarkably bold surprise movement, succeeded in scaling the Heights of Abraham from the South on September 12, and his water transportation enabled him to concentrate 5000 men in a position dominating the city before Montcalm could arrive from Beauport to confront him. The French were now compelled to attack, and the expected happened, they were completely routed and Quebec passed into British hands.

This campaign is a striking illustration of the power of the value of the defensive, and shows how it can be the proper rôle, even for both belligerents. This is a lesson which we would do well to take to heart. It also illustrates how strategy is really a struggle for the initiative, a matching of wits in order to force the opponent to give or accept action on terms most favorable to you. The superior mobility of a land force based on the water was also strikingly shown. Wolfe did not hesitate to separate his small force by distances amounting to fifty miles, because his water transportation assured him of the ability to concentrate with more rapidity than could a force on land. In many other ways the Navy assisted Wolfe, in fact it is not too much to say that without Admiral Saunders' splendid co-operation success would have been impossible. Another great advantage of amphibious operations was shown in the question of supply. For all practical purposes the British had no line of communications, they were based on the vessels accompanying them, so it was impossible for Montcalm to interfere with their supply. On the other hand Montcalm was based on Montreal, and as we have seen, it was only by operating against his line of communications with that city that Wolfe was able to control the situation, and here we have one great difference between land and naval warfare. In the army sense of the word a fleet has no line of communications, it has a base, and occasional convoys therefrom, but the daily supplies of the fleet, or of a land force based on the fleet, are carried by the ships themselves, the fleet is self-sustaining for a considerable period of time, while a land force lives from day to day on its line of communications, and must strip its mobile combatant force to guard it. This is really a question of logistics, and will be considered in detail in the thesis to come on that subject, but it must be briefly alluded to here as it plays such an important part in strategy.

The fleet requires a base with docking and repair facilities, to which it can return from time to time, but its defense is intrusted to fixed fortifications, and no mobile units are tied up there, in marked contrast with army conditions. The fleet is free to maneuver at will, and the direction of attack is influenced in no way by the direction of the base, while an army cannot uncover its line of communications without running great risk. A land force based on the water partakes of the advantages of the fleet, and this is a very important feature of amphibious operations.

It has already been stated that the ultimate aim of strategy is to secure superiority at the critical point and moment, to accomplish this requires not simply a concentration of force, but, to an even greater degree, a concentration of purpose and of effort. Except in the most unusual case it is impossible to be superior everywhere, nor is it necessary; superiority at the critical point and moment is the requirement, and all efforts must be directed to secure that result. In order to accomplish that, it is very evident that the true objective must be clearly perceived, as there is the critical point, and then all efforts must be concentrated thereon. That is concentration of purpose and effort.

Command of the sea in a maritime war is a great asset in this respect. Over 300 years ago Francis Bacon said, "He that commands the sea is at great liberty, and may take as much or as little of the war as he will, whereas those that be strongest by land are many times nevertheless in great straits."

The grand strategy of the Seven Years' War is illuminating in this connection. This war started in America, the dispute being over the control of the Ohio Valley, with the French and English colonists as the participants. The two mother countries rendered assistance, troops were sent to America and convoys waylaid on the high seas, yet the war was confined to the New World and the adjacent waters, France and England remaining nominally at peace.

This condition of affairs was manifestly to Britain's advantage; France had the superior army, but was unable to transport it to the scene of war, while England had the greater sea-force. This was the ideal of what Clausewitz calls "a war with a limited object," the object being something almost entirely dissociated from the two countries themselves. The sea-power of the opponent was compelling France to fight under disadvantageous conditions, in a theater where the enemy was strong and France weak, in other words sea-power gave England the initiative.

At that time Hanover was an appanage of the British crown, the King of England being also King of Hanover, and should the war spread to Europe, Hanover would be in danger from the French, and this would compel England to disperse her activities, or lose Hanover. Clearly this "limited war" was not in the interest of France, and therefore that country, by diplomacy, spread the theater of action, and brought on a general European conflict.

It will always be found that wars with a limited object tend to become unlimited because the losing side will attempt to strike the other at the seat of its power, however, when command of the sea is the essential element, the side possessing it will be able to foil such attempts, and so it was in this case. Although the whole of Europe was engaged in an internecine strife, France, Austria, Russia, and for a part of the time, Sweden and Spain, against England and Prussia, still, so far as England was concerned, it remained a war with a limited object, the control of America, and therein was shown true concentration of purpose.

The defense of Hanover was entrusted to a mixed command of Hanoverians, Hessians, and British, on the defensive mission of protecting Hanover and the Prussian right flank from the French army; England's main effort continued to be on the other side of the Atlantic, where she was strong and France was weak, and the navy foiled the French attempts to invade England.

Here we see concentration of effort directed against the true objective, with a containing struggle elsewhere, Great Britiain could not be superior at all points, and wisely choose the true objective, and kept the initiative. The great William Pitt was responsible for the grand strategy of this war, and his conduct thereof marks him as one of the great strategists. He clearly perceived the critical point, and the advantage which sea-power gave him to concentrate his efforts thereon, and thus keep the initiative, and he followed that course in the face of great pressure from his own King, who was fearful for his beloved Hanover; from the majority of the army, who were imbued with the ideas of continental warfare, a legacy from Marlborough's time; and from Frederick the Great, who desired more assistance in his struggle with Russia and Austria, although it must be said that the Prussian monarch, however anxious for his own safety, recognized that Pitt was playing the correct part for England in concentrating on his main objective and "containing" elsewhere.

This idea of "containing elsewhere" brings up the question of dispersion. Dispersion in strategy is not the antithesis of concentration, but is a necessary part thereof. It cannot be too often repeated that concentration means superiority at the critical point and moment, but, paradoxical as it may sound, this superiority can rarely be obtained except through dispersion, certainly the inferior force cannot hope otherwise to be superior at any point, because if the enemy is permitted to concentrate, he is, by hypothesis, superior, therefore he must not be permitted to effect his concentration, or, having concentrated, he must be induced to disperse, and the only way that that can be accomplished is by a dispersion on the part of the inferior. If the latter can, by detaching a portion of his force, succeed in keeping a superior body of the enemy away from the critical point at the critical moment, it is evident that the inferior is relatively stronger at that point. It is frequently said that concentration begets concentration, this is radically wrong, if the superior concentrates it will compel the other to disperse, in order to reduce the disparity. If the inferior concentrates then the superior can do so, as he is thereby freed of the great difficulty which confronts the superior force, that of overcoming the dispersion of the enemy, but it is evident that true strategy requires a dispersion of the inferior, provided he can thereby cause a still greater dispersion of the enemy.

In order to accomplish that result one of two conditions must be present; (1) the detachment from the inferior force must be able to take up such a position as to be able to forcibly prevent a superior force of the enemy from joining its main body; this requires an interposition between the two enemy forces, and the utilization of terrain for a defensive engagement; or, (2) it must be directed against an objective which the enemy cannot afford to lose, which will therefore compel him to detach a superior force for its protection. The first of these is usually called an operation on interior lines, the second a strategical diversion. In both cases the operation is justified only if it thereby keeps a *superior* enemy force from the critical point, otherwise no advantage is gained, in fact the inferior is relatively weaker than before. In land warfare this is called a containing action, and the superior force is said to be contained, and, inasmuch as this term is very loosely used in naval warfare it will be best to illustrate it by a purely land campaign, and the Virginia campaign of 1862 is selected, as it is one of the most brilliant examples in history of the manner in which an inferior force can succeed in being superior at the critical point and moment.

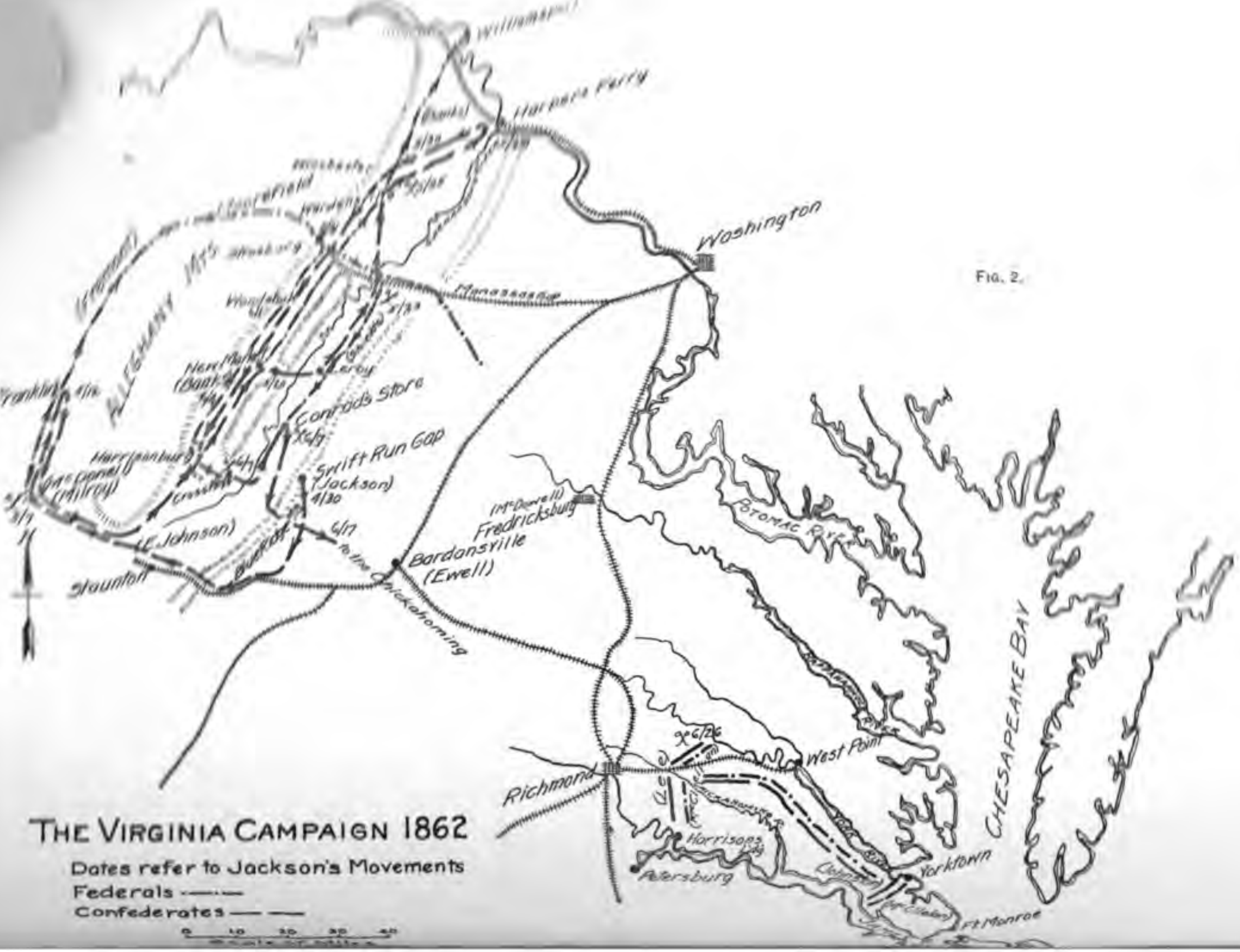
At the end of April McClellan was operating in front of Yorktown with about 100,000 troops; McDowell was at Fredericksburg with 40,000; Banks in the Shenandoah, with about 15,000 at New Market, and a strong detachment at Harrisonburg, Fremont, with a force of 15,000, had been in West Virginia, and was now en route to join Banks, a detachment of 3000 being at McDowell under Milroy, the remainder between Franklin and Moorefield. In addition there were 20,000 to 30,000 troops within the defenses of Washington, in all approximately 200,000 Union troops in this area.

The Confederates had about 50,000 under J. E. Johnston opposing McClellan; 6000 under Jackson at Swift Run Gap in the Valley; 8000 under Ewell at Gordonsville; and 3000 at Staunton under Ed. Johnson, a total of only about one-third the Union armies.

McClellan's and Johnston's forces were, of course, the main armies, the former being about double the latter, and Richmond was McClellan's objective. Jackson had been fighting Banks, and had been pushed southwards down the Valley from Winchester, so it was considered that the Union armies had the situation there in hand, and Shield's division had been ordered from Banks to join McDowell, the latter was then to march south to form a junction with McClellan in front of Richmond. The superior force was planning to concentrate about 150,000 men, or more than double the entire Confederate forces.

Obviously the Confederacy was doomed to destruction if this plan could be carried out, since they would be so inferior

Fig. 2.



THE VIRGINIA CAMPAIGN 1862

Dates refer to Jackson's Movements

Federals —·—

Confederates — —

at the critical point and moment, the only chance was to prevent such a concentration.

Lee, in Richmond, was in general charge of the Confederate operations, and he directed Jackson to make a threat against Washington in order to contain McDowell's army; Ewell and Ed. Johnson were placed under his command. Here we see fulfilled the condition that a strategic diversion must have, as an objective, something that the enemy cannot aflord to lose, otherwise he may ignore the threat, and Lee counted on the extreme solicitude which the Federal Government had always shown for the safety of the capital, and he was not disappointed. We also see that the other requisite for a containing action, that the force to be held must be superior, was fulfilled, Jackson's united force was only 17,000, while McDowell alone had 40,000, Banks and Fremont together 30,000 more.

Jackson's movements were so illuminating that they deserve to be given in considerable detail[1]. He first marched (April 30) against Milroy, uniting with Johnson en route, and leaving Ewell to contain Banks. Milroy, it will be remembered, had but 3000, Jackson and Johnson together 9000. Ewell had 8000, Banks 15,000. We see again the effect of the containing force, in this case it was interposed between the two Union armies, in other words Jackson was operating on interior lines. We also note that Jackson had superiority in his main action, and that he selected the weakest detachment opposed to him. Milroy was overwhelmed, and Jackson pursued to Franklin, where Fremont appeared (May 12) and stopped the victorious Confederates.

Jackson then returned to the Valley, leaving his cavalry to screen his movements from Fremont. Shields had left Banks by this time, and was en route to join McDowell, so that Banks was reduced to 8000 men, and of these he put 1000 under Col. Kenly at Front Royal, to guard the Manassas Gap Railway, retreating with the remainder to Strasburg. Ewell joined Jackson and the entire force moved (May 21) against Front Royal, annihilating Kenly's detachment. Again Jackson chose the weakest enemy.

Banks then retreated to Winchester, Jackson followed, the Union troops were defeated and forced across the Potomac at Williamsport; Jackson had a superiority of at least two to one over Banks. He then threatened Washington by marching on Harper's Ferry, and the results of the campaign became apparent. McDowell's movement to join McClellan was countermanded, and instead he was ordered to send 20,000 against Jackson, and even McClellan was warned that he might be recalled for the defense of Washington. Jackson, with 17,000 troops, had paralyzed the operations of 200,000.

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[1] See Fig. 2.

His force was now reduced to 15,000, and he had 2000 prisoners and a long train of wagons, containing much captured booty. Fremont moved towards Strasburg, from the west, and Shields, with 20,000 from McDowell, towards Front Royal from the east. Jackson returned to Winchester, leaving a brigade to contain Banks, now re-enforced to 15,000.

On May 31 Fremont was at Wardenville, Shields at Front Royal, the head of Jackson's column seven miles north of Winchester, all three were marching on Strasburg, Fremont was 25 miles away, Shields 16, Jackson 25, and the tail of the Confederates, the brigade left to contain Banks, was 20 miles farther, however Jackson held his flanks with small containing forces and the entire column got through to Woodstock in safety. Fremont followed, while Shields marched to Luray.

On June 6, Jackson was at Cross Keys, Fremont at Harrisonburg, Shields advanced troops at Conrad's Store, main body near Luray. Ewell was left to contain Fremont, while Jackson advanced on Conrad's Store, and drove back the Federals until the arrival of Shield's main body stopped the pursuit. In the meantime Fremont had attacked Ewell unsuccessfully, and Jackson returned, re-uniting his command, and on June 17, marched secretly to the Chickahominy.

In the meantime, in the Peninsula, Johnston had slowly fallen back on Richmond, followed by McClellan. Lee then took personal command of the army, now re-enforced to about 75,000, and after Jackson joined from the Valley, he took advantage of McClellan's position astride the Chickahominy to throw a superior force against one flank, while holding the other. McClellan had about 30,000 under Porter, north of the river, and something over 65,000 on the south side. Lee attacked Porter with 65,000, while the superior Federals on the south were contained by Magruder with 25,000. Here again we notice that the offense was directed against the weaker force. Porter was defeated and forced to the southward, and McClellan's line of communications to White House was uncovered. Fortunately for the Union army, the navy had, in the meantime, secured control of the James River, so that McClellan was able to fall back on Harrison's Landing, and establish a new base at that point, and thus save his army. Again we see the advantage possessed by an army based on the water, when command of the water is secured.

This campaign illustrates the possibilities of the defensive, when the force undertaking it is inspired by an animus pugnandi. It is also another example of the belligerent on the defensive acquiring the initiative, Lee delayed decisive action until he was able to be superior at the critical point and moment, and he secured this result by a strategic diversion. Jackson, with 17,000 men, not only contained a force of 70,000, but by brilliant strategy and hard marching was able to be superior at every critical point of contact, and finally joined his main body in time to take part in the crucial engagement, while his former opponents were still hunting for him in the Valley.

Then Lee employed similar tactics, he had 90,000 against McClellan's 100,000, nevertheless he secured a superiority of over two to one at the critical point. The fact that both Lee and Jackson invariably chose the weaker force opposed to them as the object of attack, is not without significance, in view of the discussions which have prevailed recently as to the proper strategical procedure in the present European War.

In the light of this campaign we can better appreciate the essential requirement of a containing force, that it must keep a superior away from the critical point.

The Seven Years' War is usually remembered in military circles on account of the land campaigns of Frederick the Great, but that was the least important part of that struggle for us; England's part therein was amphibious, and the most valuable lessons that we can derive from the war are the methods by which sea-power can be utilized to nullify superior land forces.

The grand strategy of that war has already been stated, and it will be remembered that England commanded the seas, that her main effort was in America, and that her land forces were comparatively small. A small force held Hanover and covered the Prussian right flank from the French army[1]. This was essentially a containing force, as it was preventing the French from forming a junction with the Russians and Austrians, against whom Frederick the Great was barely holding his own, and there can be hardly any doubt that not even Frederick's genius could have saved Prussia, had the French succeeded in uniting with their allies against him.

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[1] See Fig. 3.

The Hanoverian force was kept at a minimum in order not to weaken the main offensive in America, and, for the purpose of assisting it, Pitt made a number of strategical diversions against the French coasts, in order to hold land forces away from the Hanoverian theater, to prevent the forces in France from being used as a reserve for the Grand Army, which was operating under the Duke de Richelieu, against the British-Hanoverians. In accordance with the fundamental principle which must be the basis of such diversions, they were directed against objects of importance to France, principally the naval bases, and France never knew where the blow would fall next.

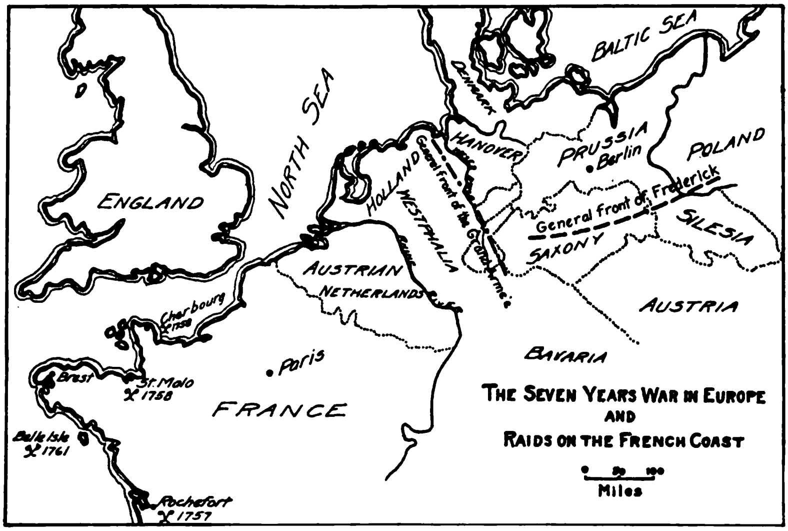


FIG. 3. 2166

In October, 1757, a joint expedition, having a land force of 10,000 men, was dispatched against the naval port of Rochefort, in which were then lying fourteen ships of the line, eight frigates, and several smaller vessels. Considered as an operation by itself, it was a miserable failure, the naval and military authorities could not agree on any plan, and the expedition returned, having done nothing. But, as a containing operation, which was its real object, it certainly succeeded. At that time the French had not over 10,000 men on the entire west coast, but the appearance of the British expedition caused at least seventeen battalions to be hastily gathered from various points and sent to Rochefort at once, and twelve battalions of infantry with thirty squadrons of cavalry were taken from the Grand Army on the Hanoverian front for duty in coast defense, and a little later 24,000 more were withdrawn.

In May of the following year, a similar expedition was sent against St. Malo, where four ships of the line and sixty-two merchantmen were destroyed, and the raid was continued along the north coast.

In August a third expedition sailed, this time against Cherbourg, where the docks were ruined, the forts rased, and twenty vessels destroyed, St. Malo was again attacked and more damage inflicted.

The effect of these raids on the French was shown by the withdrawal in August of fifteen battalions of infantry and several regiments of cavalry from the Grand Army. By the end of 1758 France had between seventy and eighty battalions of regulars immobilized as a coast defense because of uncertainty as to where the British would make the next raid. Some of that force would undoubtedly have been on the coast anyway, but 30,000 is a conservative estimate of the surplus force France had to retain on her coasts, and which would otherwise have gone to swell the Grand Army in Hanover. In other words Pitt's expeditions, which numbered from 10,000 to 13,000, contained a force of from two to three times its own strength. Would the British victory at Minden in 1759 have been possible had those 30,000 troops been with Richelieu? When the closeness of the operations in Hanover are considered, how the line swayed first this way and then the other, it seems reasonable to assume that the force thus contained might easily have destroyed the balance, and opened a way for France to Frederick's right flank, or compelled England to abandon its concentration in America.

It was not merely the raids themselves, but also the threat which was always present after the Rochefort attempt, the knowledge that command of the sea enabled the British to descend at will on any part of their coast, that caused so much uneasiness to the French, and compelled the retention of such a strong force, and this is the great advantage possessed by sea-power in land operations, the facility with which armies can be moved from point to point, the uncertainty attending the movements, and the ever present danger along the whole coast.

In the Crimean War the Allies were in absolute command of the sea. All land operations were conducted in the Crimea, in southern Russia, but the Allied navies controlled the Baltic, and the possibility of an invasion from that sea,with St. Petersburg as the objective, was sufficient to hold a large portion of the Russian army in that vicinity, away from the theater of actual hostilities. No such attempt was made, nevertheless land forces were contained simply through the *possibility* of such action.

Similarly in 1807 Napoleon wrote "With 30,000 men in transports at the Downs, the English can paralyze 300,000 of my army."

The importance of this point to a nation like ours, having a strong navy and a small army is apparent. It is doubtful whether any strategical diversion has such great possibilities as this.

We have considered the methods by which a superiority in land forces can be neutralized, it is now time to turn to pure naval strategy, and consider that question from the standpoint both of the inferior and of the superior, since this country might be in either situation.

How can the principles of the strategical diversion and the containing force be applied at sea, in order to enable the inferior to be superior at the critical point and moment?

We noted, in reference to land warfare, that the containing force must either work on interior lines and be able to take a position so as to forcibly prevent a superior force of the enemy from joining its main body, or it must be directed against an objective which the enemy cannot afford to lose, and which will therefore compel him to detach a superior force for its protection.

In the first of these alternatives the containing force relies on the defensive power of intrenchments of the natural features of the ground, to fulfil its mission, by that means the inferior is able to halt or delay the progress of the superior, but no such condition exists at sea; there are no roads along which the fleets must move, the entire sea is a highway and forms one road of practically unlimited extent; there are no natural features which lend themselves to defense, except the few straits which can be commanded by land batteries; and no artificial protection is possible for ships at sea, a fleet cannot dig in and thus hold a superior. An inferior naval force can escape destruction after it is once detected by speed alone; if it stops to engage it is lost, and this was the basis of the suggestion made by Kempenfeldt, the British Admiral, at the time of the American War of Independence, that by the use of faster vessels in a "Squadron of observation" they would be a "check and restraint upon the enemy's motions," in other words would have a containing effect. But it can, at best, be very limited, and in general it can be said that containing actions, such as were employed by Jackson in the Valley campaign, are not possible at sea.

The other alternative however offers more opportunities. We have seen that the object of naval warfare is to secure control of maritime communications, and that those communications have both a commercial and a military importance, the superior therefore cannot afford to lose control of trade routes, so a strategical diversion might be produced by threatening them. The immense size of the ocean and the innumerable possible courses thereon renders the detection of a small naval detachment difficult, and it can safely be assumed that a superior naval force will be necessary to hunt down a detachment raiding commercial routes of travel. The German use of submarines in the present war shows the possibilities of small craft used for this purpose. Furthermore any type of armed vessel is suitable for the raiding force, owing to their high speed and large cruising radius probably converted liners are the best of all for such a purpose, (except perhaps submarines), and their detachment would in no wise weaken the main battle fleet, while the enemy might be compelled to detach some essential elements of his battle fleet in order to protect the commercial routes, or to convoy his merchantmen or military or naval supply vessels and transports, and we would then have the true strategical diversion.

The actions thus undertaken against commerce do not have that commerce as the real objective, Admiral Mahan has pointed out the futility of such a conception of naval warfare; the object is to compel a separation of a superior force from the enemy's main fleets, in order to obtain superiority at the critical point and moment.

Looking at this from the viewpoint of the superior it is evident that a large number of fast armed auxiliaries will enable trade routes to be protected without weakening the battle fleet, so the great importance of the armed liner, or any merchantman, if of large size and high speed, to both the superior and the inferior navy is apparent. It would be impossible to have too many of them, and it would seem good policy to make use of this to assist in building up our merchant marine.

Raids by joint expeditions against territory of the enemy, the more distant from the main theater the better, can also be employed as strategical diversions. A threat of this character is almost certain to hold superior naval forces away for the protection of the territory. This form of strategical diversion was utilized by both the French and British in the eitgheenth century, the West Indies being the most frequent scene of the eccentric attacks.

Joint expeditions can be used therefore to contain either land or naval forces, or both, as the situation renders it possible.

If the inferior naval power is unable to prevent the concentration of the superior nothing remains but the protection of a fortified harbor, and it is then, for all practical purposes, removed from the theater of operations, as it has surrendered its own element to the enemy, who thereby obtains the de facto command of the sea. But this command is not absolute so long as the inferior force is ready and desirous of issuing forth, when a suitable opportunity arrives, and such an occasion would be presented where it able to bring to action an inferior detachment of the other. It is therefore evident that the superior must keep continual observation of the fortified port by a fleet superior to that sheltered within. This is sometimes called "containing," but it is evident that it does not conform to the military use of that word, it cannot even be said that the inferior fleet in the harbor is containing the superior outside, because it is the power of the land batterries that is the deterrent factor, not that of the fleet itself. In order that there can be no misunderstanding it is better to call this a naval blockade, and it is evident that the motive of the blockading force will rarely be to keep the enemy sealed up, but rather to lure it forth, in order that the superiority of the blockader can be made effective. So long as the inferior fleet remains in port it is sheltered by the fortifications, but the superior desires to destroy it and thus make his command of the sea absolute, and this can only be accomplished by permitting the inferior to put to sea. At least that is the only way by the use of sea forces alone, but land forces may be used in connection therewith, as at Port Arthur in 1904, Santiago in 1898, and in the raids on the French coast of the Seven Years' War to which allusion has already been made. So once again we see the value of amphibious operations, combined expeditions directed, in this case, against the sea-power of the enemy. However it should be noted that with inferior land forces it is rare that this operation can be undertaken.

If such joint operations are not possible, the inferior must be induced to put to sea, and it is evident that a close investment by a superior force is not likely to tempt the sheltered fleet to forsake its security..

A stringent commercial blockade may be so effective in the suspension of the enemy's commerce and in paralyzing his economical and financial condition, that the fleet will be forced to make an attempt to break it down. The present naval situation in Europe is perhaps an illustration of this.

Another method open to the superior can be best exemplified by the dispositions of the British and Allied fleets before Trafalgar. The French and Spanish fleets were dispersed in various ports along the Atlantic and in the Mediterranean, and Napoleon was organizing an army for the invasion of England. The British distribution was based on four strategic centers; first, in the Channel; second, off Ushant; third, off Cadiz; and fourth, off Toulon. Each of these centers was linked up to adjacent groups, thus there was a high degree of cohesion, although an appearance of great dispersion. No attempt was made to keep the Allied fleets in port, on the contrary every inducement was offered for them to put to sea. The dispersal of the British was enforced by the enemy's dispersal, and, inasmuch as the former was superior, it was evidently more to its interest to permit the enemy to concentrate,—provided its own concentration could be effected in time to prevent the Allies from falling on an inferior British unit,—than to keep the Allied forces so greatly dispersed that they would not accept battle.

The British dispositions tempted the Allies to concentrate, and this solved the problem for England, and gave that country the initiative, its fleets were really in a form of loose concentration rather than in dispersion, and the battle of Trafalgar ensued. In other words the British dispositions had an appearance of weakness, but a reality of strength, similar to those of Wolfe at Quebec, and therein lies the secret for the concentration of the superior. A close massing of forces will inevitably tend to make the inferior disperse, or seek shelter, and this is distinctly opposed to the interest of the superior, who desires that the decision be quickly made.

The close inter-relation between land and naval strategy is seen even in the Trafalgar campaign, which, superficially, appears to be a purely naval matter. It was really the land situation in Italy and the dispatch of a military expedition from England to Malta that caused Villeneuve to sail from Cadiz to destruction at Trafalgar. That was the compelling force, and the apparent weakness of the British dispositions was the allurement.

The attempt has now been made to show the general features governing the initiative and concentration, two principles which lie at the root of all strategy. It is hardly too much to say that a proper application of these comprises the entire art, because victory will rest with the belligerent that is able to force the opponent to accept battle under conditions of inferiority.

Attempt has also been made to show the application of those principles to conditions of American strategy, the close correlation which exists between the army and the navy. In amphibious warfare military problems cannot be solved in watertight compartments, each service is dependent on the other, and the operations must be so linked as to form an harmonious whole.

Predicting Instruments

The following descriptions, plans, and photographs of predictors, which have been recently submitted to the Coast Artillery Board for test, are published in the JOURNAL by direction of the Chief of Coast Artillery.

This is published to the service for the purpose of stimulating study in the development of suitable instruments and methods for this purpose, as well as to give the service the benefit of the information before the Coast Artillery Board, in order to facilitate the making of improvised types for use locally.

THE FRANK PREDICTOR

Fig. 1.

(Designed and submitted by Capt. Jacob Frank,
C. A. C., U. S. A.)

This instrument solves graphically the equation

$$S = T\left(1 + \frac{t}{N}\right)$$

in which

S = Set forward distance from the last plotted point.
T = Travel during observing interval.
t = Travel during time of flight.
N = Observing interval in seconds.

The solution is effected by the graphic construction of two similar triangles, the ratio of whose dimensions is $\frac{T}{T+t}$.

The instrument solves the equation upon sound mathematical principles, and is theoretically correct. The instrumental error apparent in this sample could be largely eliminated in a carefully designed and properly made instrument.

It would seem to be particularly well adapted to mortar work, and it is suggested that two travel arms be provided, each to be held against its own travel stop by a spring. This would in no way interfere with the handy operation of the

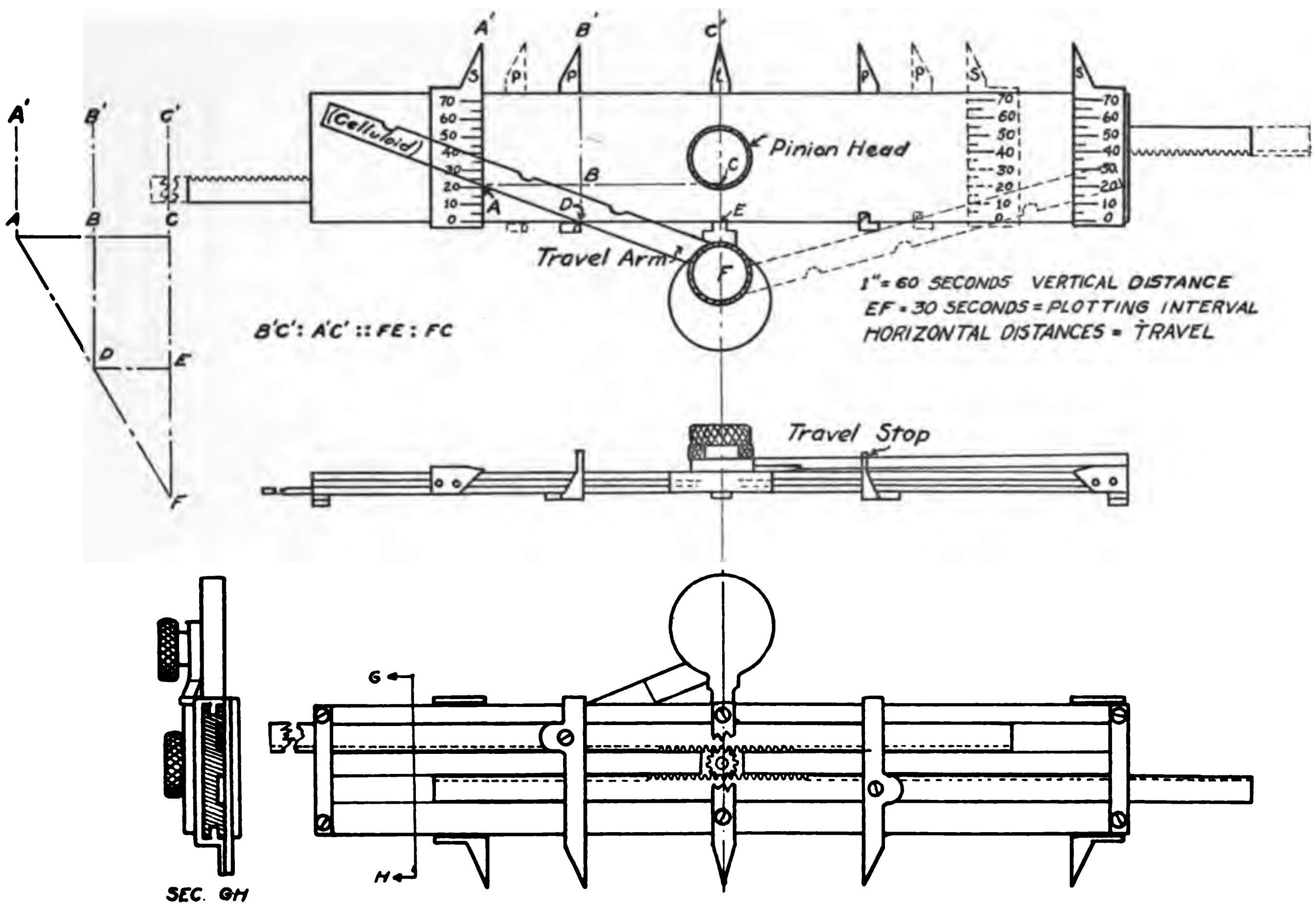


Fig. 1. Universal Set-Forward and Predicting Plotter.
Designed by Captain Jacob Frank, C. A. C.

instrument, and would avoid the necessity of changing the travel arm for a reverse track. The set-forward pointers should be provided with spring frictions against the body of the rule, and with plunger targs for taking the mortar arm readings. Any further complication of mechanism is not advised.

Operation

Place the central pointer C' on the last plotted point. Turn the pinion head until movable pointer p reaches the previous plotted point. Swing the fiducial edge of travel arm against the travel stop D. Slide the time-of-flight pointer until the proper graduation intersects the travel arm at A.

B' now indicates the predicted point and A' the set-forward point.

Four manual operations are required, including the depression of a spring targ, if provided.

MOODY-CUMMINGS PREDICTOR

Fig. 2.

The construction and operation of this device is clearly shown in the drawing. In view of the fact that the predicted point and the set-forward point are attained by separate and dependent operations, it is a trifle slow and confusing.

Operation

Place the fixed pointer O on last plotted point. Rotate the large pinion head until pointer L coincides with previous plotted point. Pointer S will now indicate the predicted point. Now set the time-of-flight arm to proper reading and translate thumb-nut G to the right until stud D meets the travel arm. The pointer S will now indicate the set-forward point.

Manual operations, five, including the pricking-in of both predicted and set-forward points.

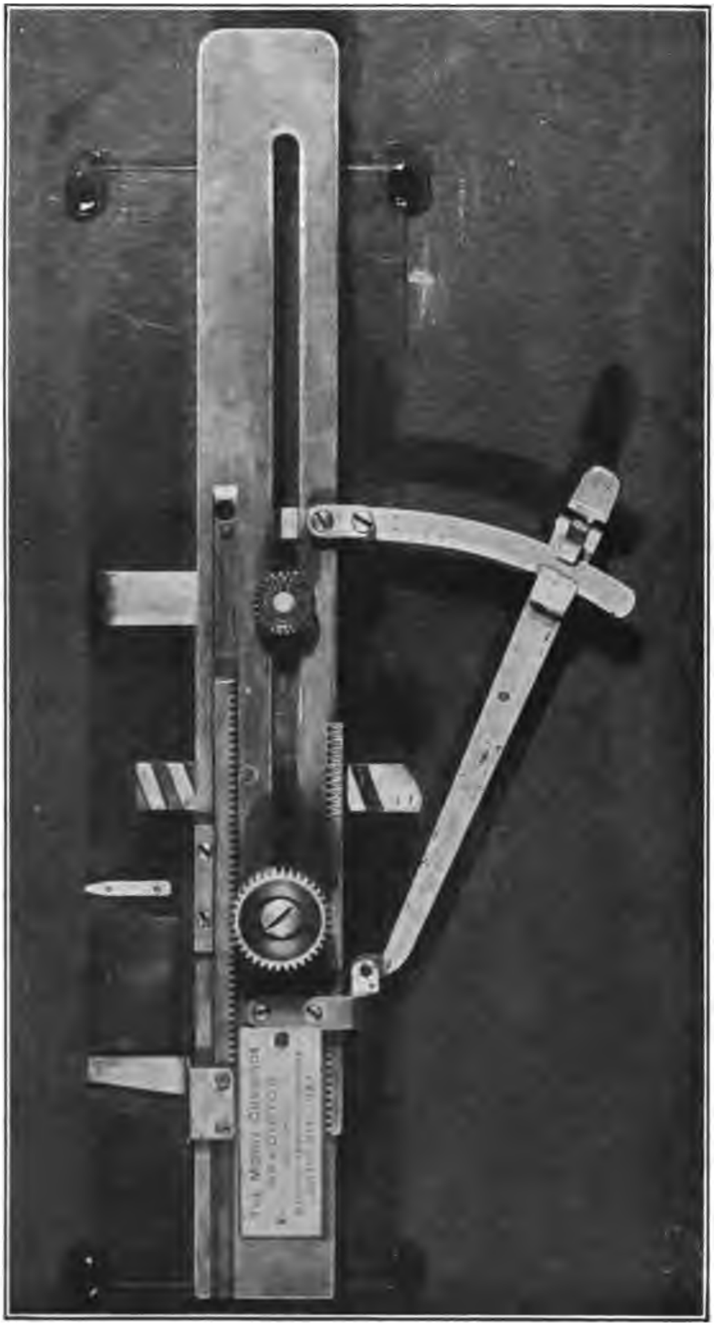
Fig. 4.

This is a smaller type of Moody-Cummings predictor, fairly accurate for low rates of travel, but introducing erroneous motions which destroy its mathematical accuracy.

Operation

Similar to No. 2 as to the predicted point, but the set-forward point is located by the motion of the time-of-flight arm.

Number of manual operations, five.



2180

FIG. 2. MOODY-CUMMINGS PREDICTOR. (1.)

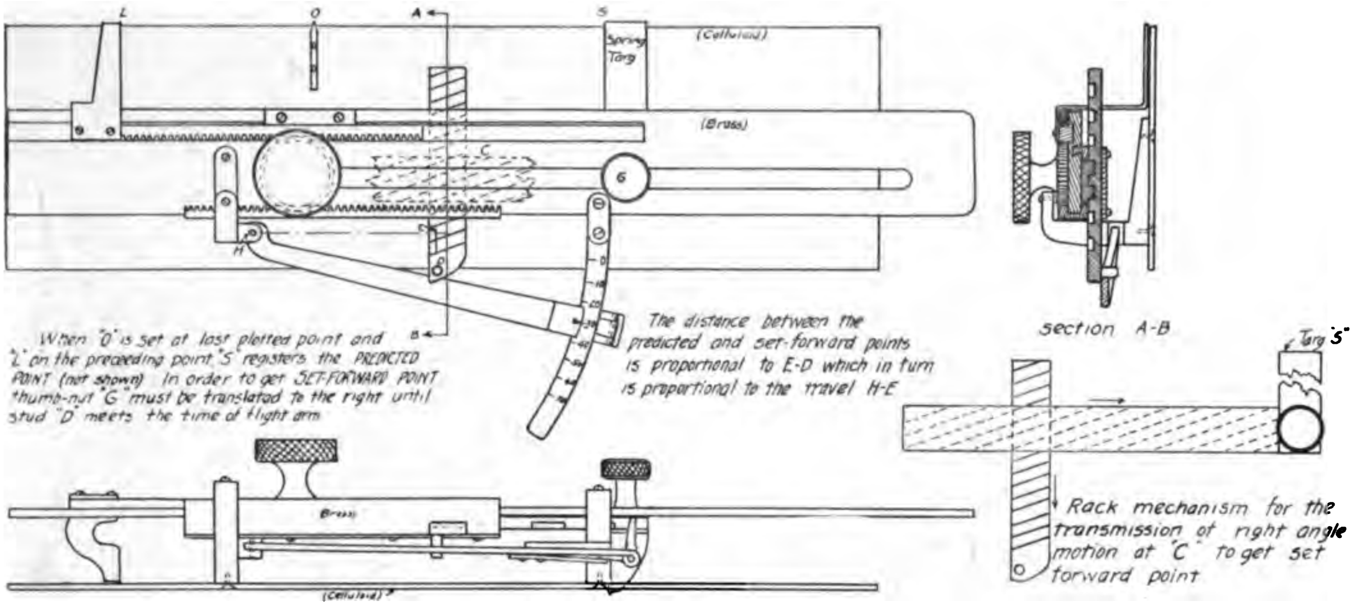

L
O
A
S
Spring Targ
(Celluloid)
(Brass)
C
G
D
E
H
B
When "O" is set at last plotted point and "L" on the preceding point "S" registers the PREDICTED POINT (not shown). In order to get SET-FORWARD POINT thumb-nut "G" must be translated to the right until stud "D" meets the time of flight arm
The distance between the predicted and set-forward points is proportional to E-D which in turn is proportional to the travel H-E
Brass
(Celluloid)
section A-B
Targ "S"
Rack mechanism for the transmission of right angle motion at "C" to get set forward point

FIG. 3. MOODY-CUMMINGS PREDICTOR. (1.) SECTIONAL VIEW

2161

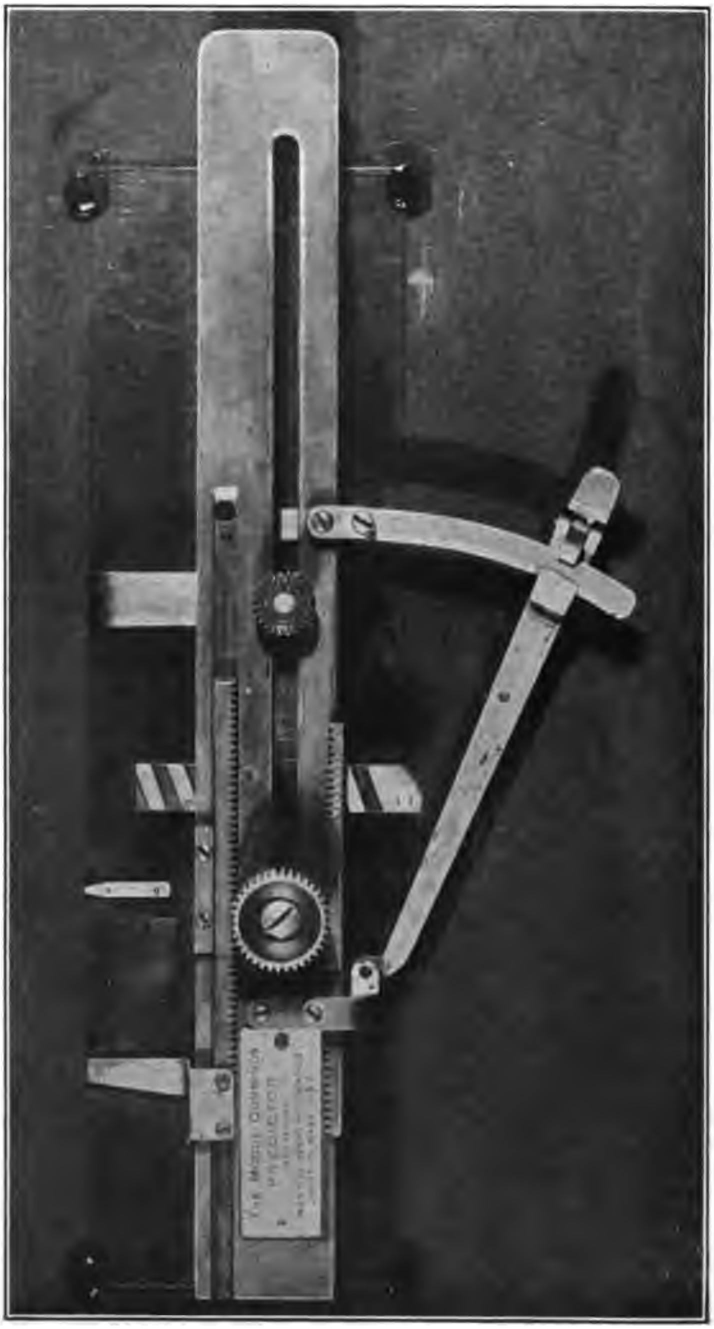


FIG. 2. MOODY-CUMMINGS PREDICTOR. (1.)

3180

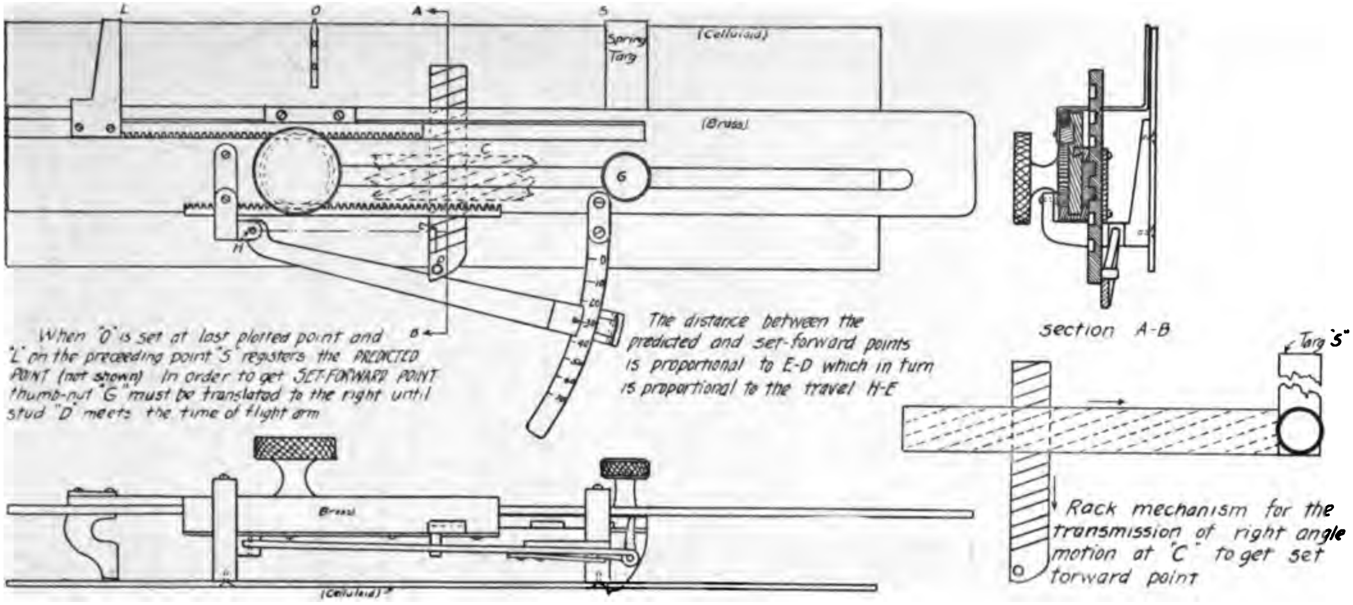

L
O
A
B
S
Spring Targ
(Celluloid)
(Brass)
C
G
H
E
D
When "O" is set at last plotted point and "L" on the preceding point "S" registers the PREDICTED POINT (not shown). In order to get SET-FORWARD POINT thumb-nut "G" must be translated to the right until stud "D" meets the time of flight arm
The distance between the predicted and set-forward points is proportional to E-D which in turn is proportional to the travel H-E
Section A-B
Targ "S"
Rack mechanism for the transmission of right angle motion at "C" to get set forward point
Brass
(Celluloid)
2161

FIG. 3. MOODY-CUMMINGS PREDICTOR. (1.)
SECTIONAL VIEW

Fig. 6.

Moody-Cummings predicter of smaller but similar construction to No. 4.

Operation

Similar to No 4.

The same mechanical errors are encountered, although they are negligible for ordinary rates of travel.

Number of manual operations, five.

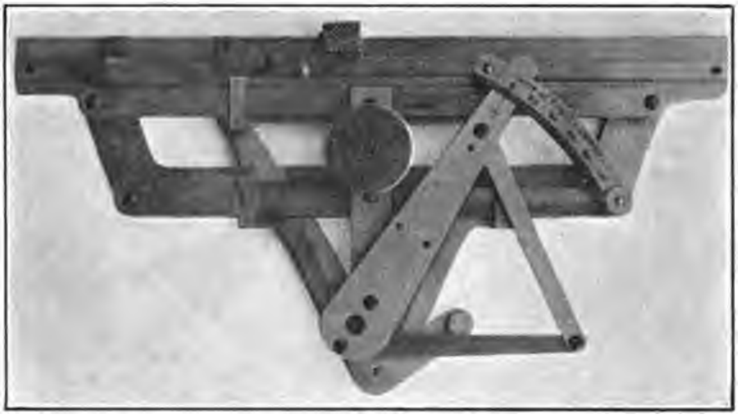


FIG. 4. MOODY-CUMMINGS PREDICTOR. (2.) 2162

Fig. 8.

This predictor was developed by the Coast Artillery Board, but is similar to one designed by Lieutenant Maurice B. Willett, C. A. C., in 1914

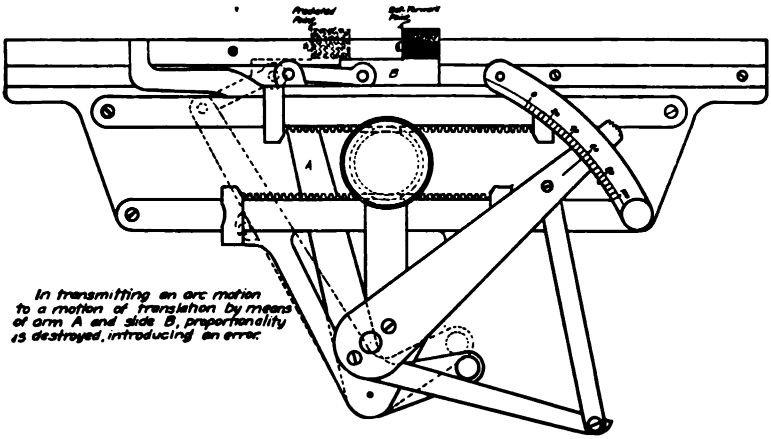

Predicted Point
Set Forward Point
A
B
In transmitting an arc motion to a motion of translation by means of arm A and slide B, proportionality is destroyed, introducing an error.

FIG. 5. MOODY-CUMMINGS PREDICTOR. (2.) 2163
SECTIONAL VIEW

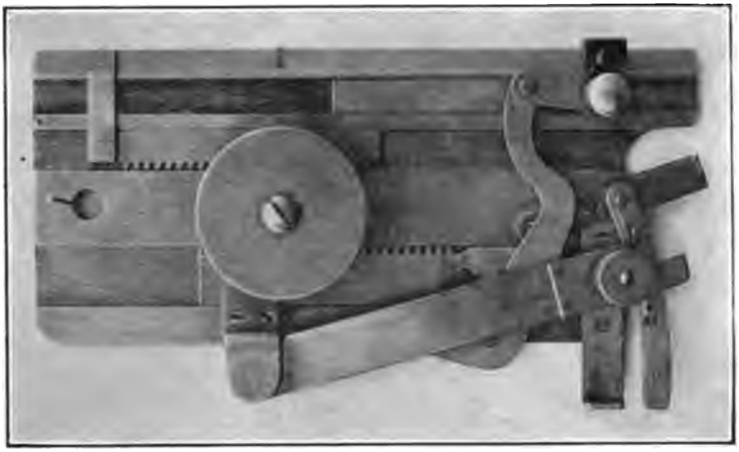
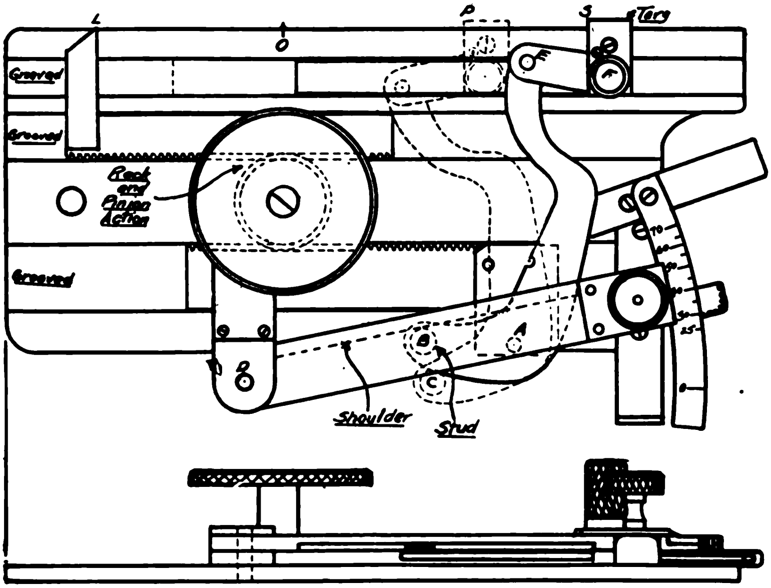


FIG 6. MOODY-CUMMINGS PREDICTOR. (3.) 2164



The mechanism of this predictor attempts to transmit proportional arc motions at A-B-C to proportional translatory motions at P-S. An error is thereby introduced which makes it too inaccurate for most large travels.

FIG. 7. MOODY-CUMMINGS PREDICTOR. (3.) 2165
SECTIONAL VIEW

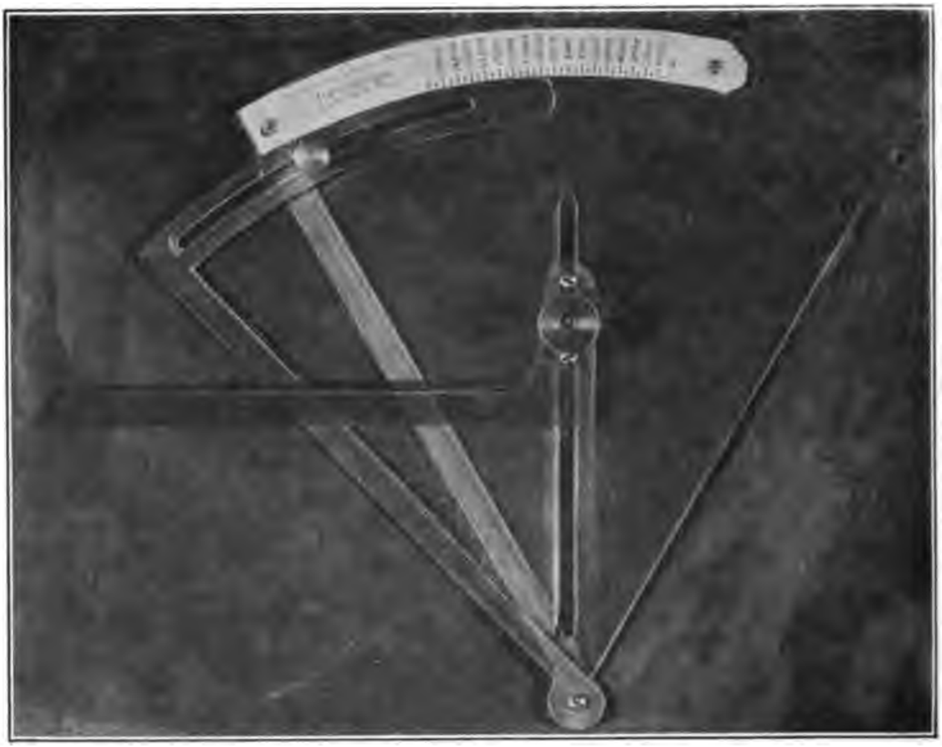


FIG. 8. WILLETT-COAST ARTILLERY BOARD PREDICTOR. (1.) 2166

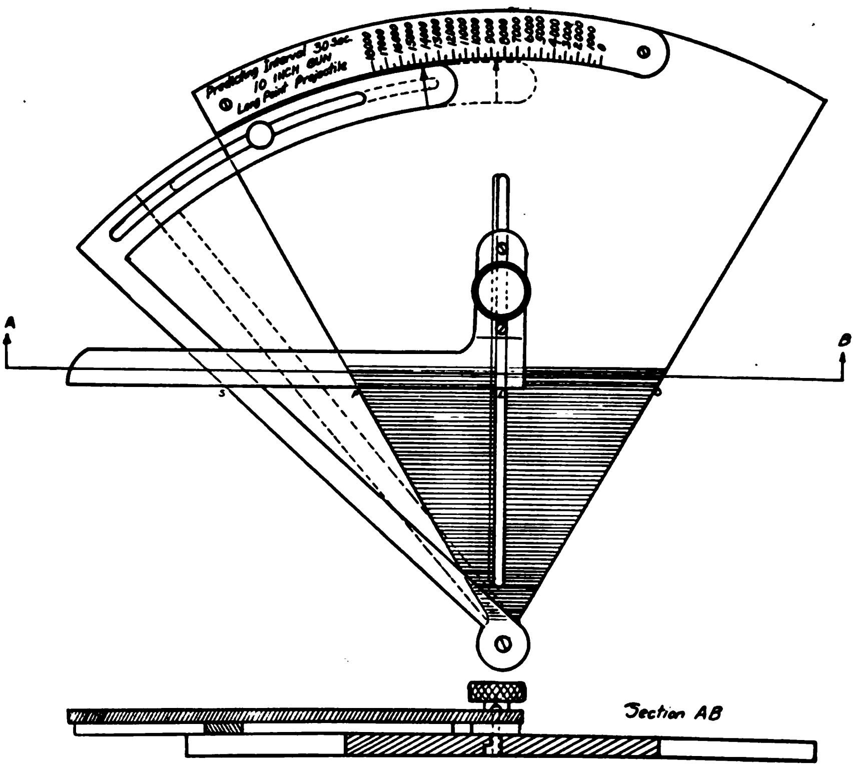


FIG. 9. WILLETT-COAST ARTILLERY BOARD PREDICTOR. (2.) 8167
SECTIONAL VIEW

Range scales may be substituted for any given gun and projectile. The entire instrument is made of transparent celluloid. The vertical slot in the base is laid over the last plotted point and normal to the track. The instrument is then moved up or down until the previous plotted point appears at the right-hand diagonal edge. The ruler is moved until it lies along the track. The intersection of the ruler and travel arm now indicate the set-forward point. In the case of a reverse track the instrument must be inverted.

It is not suited for very low target speeds, on account of the width of neck at the pivot.

Number of manual operations required, four.

Range, or time of flight, may be set during the interval before the bell.

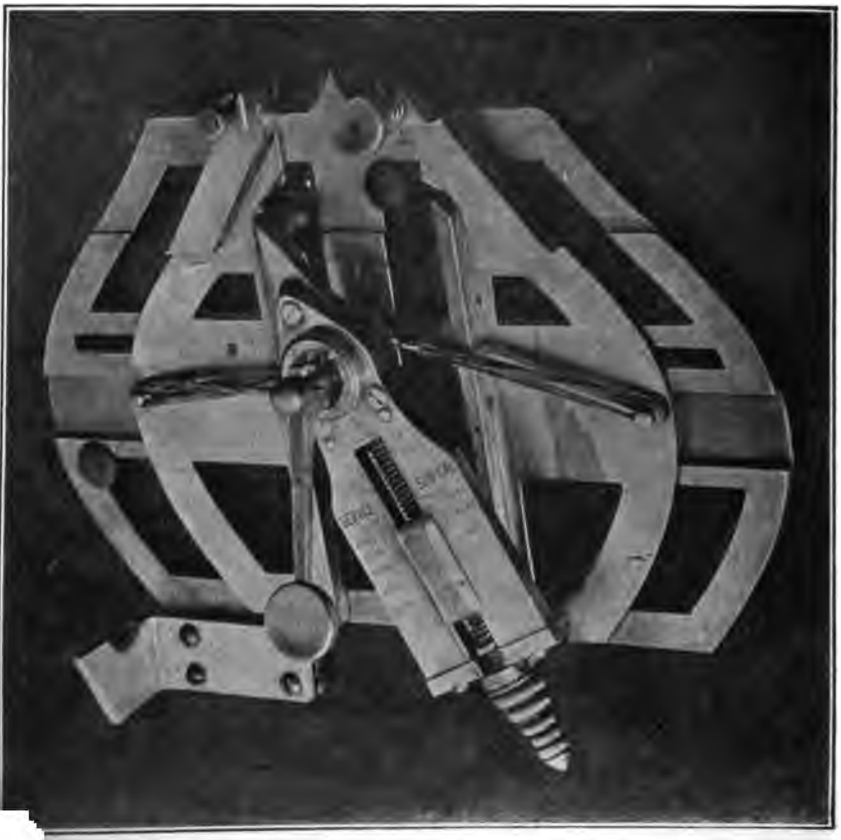


FIG. 10. FROST PREDICTOR. (1.) 3165
DESIGNED BY 1ST LIEUT. C. M. FROST, CAL. N. G.

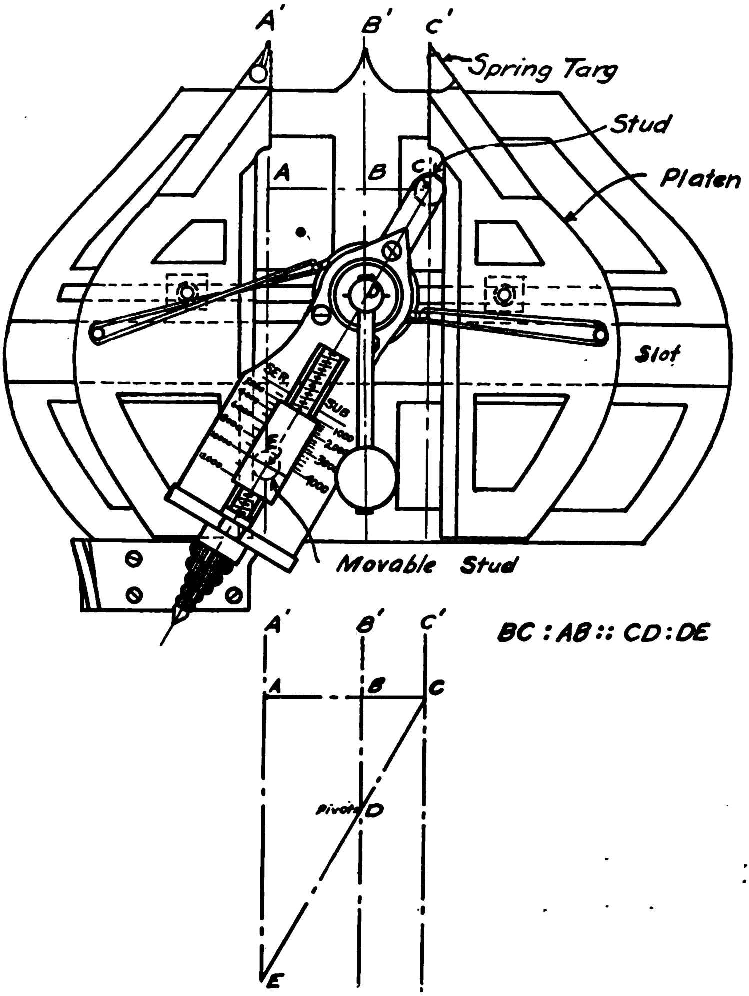


FIG. 11. FROST PREDICTOR. (2.)

2169

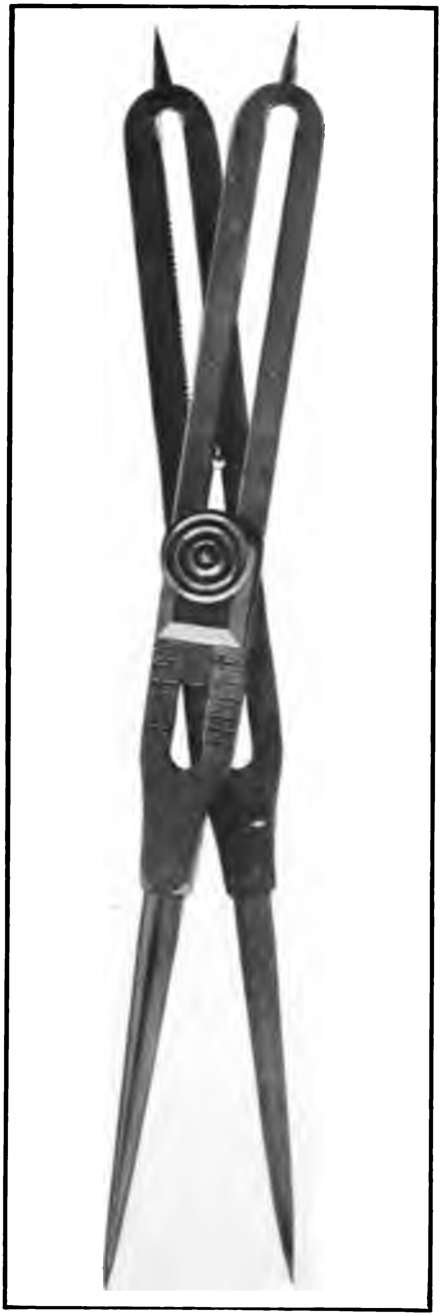


FIG. 12. PROPORTIONAL DIVIDERS PREDICTOR. (1.)

2170

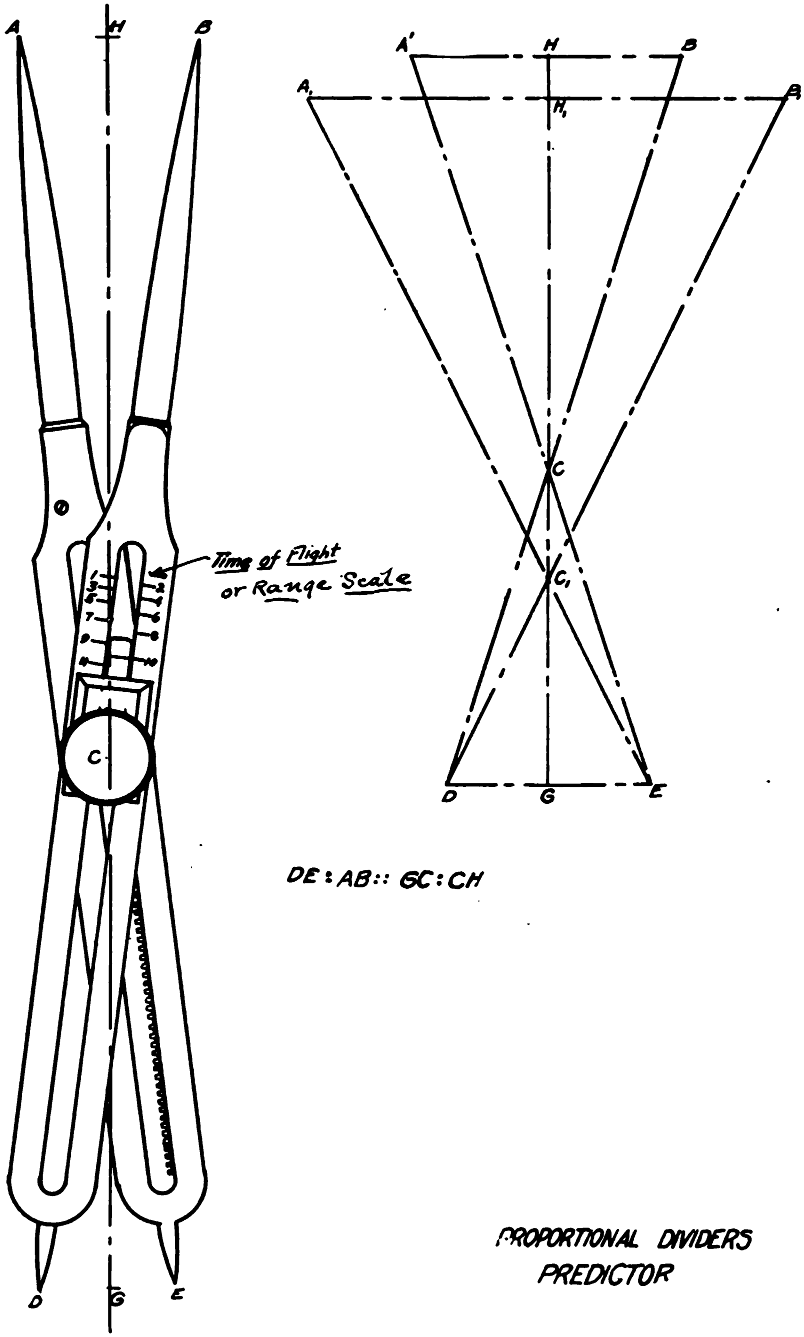


FIG. 13. PROPORTIONAL DIVIDERS PREDICTOR. (2.) 2171

The Frost Predicter

Fig. 10.

(Designed by Lieut. C. M. Frost, Calif. C. A., N. G.)

The principle and general construction are shown in the drawings. In use, the fixed central pointer is set to the last plotted point, the rear end of the range bar is swung in the direction of the motion of the target until one of the pointers reaches the previous plotted point. The other pointer will now indicate the set-forward point. Its plunger targ is pushed down and the gun arm brought up to it for the range reading. The instrument may be used with equal facility for right or left hand tracks.

There being no predicted-point indicator, it is not suitable for mortar work. It is mathematically correct.

Number of manual operations required, three.

Fig. 12.

The figure shows a suitable type of proportional dividers, graduated for use as a predictor. The scale may be divided in seconds of time of flight, for mortar use, or in terms of range for use with major armament.

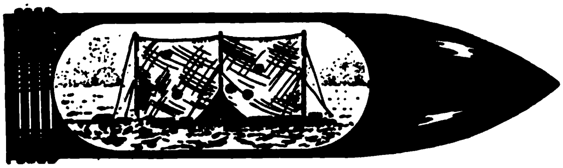
This type of predictor is easily graduated, mathematically correct, and reasonably handy to use.

Operation

Having set the index of the central pivot to last range called, adjust the smaller end to the last recorded travel, reverse the instrument, and prick out the set-forward point on the probable continuation of the track.

Number of manual operations, three.

Several very good improvised devices have been published to the service through the Journal U. S. Artillery during the last three years.



A Field Ballistic Problem

The following problem is based on "Notes on Ballistics" by Colonel Alston Hamilton, C. A. C. and Major George A. Wildrick, N. A., (C. A. C.). The purpose of the problem is to give an Artillery Officer a working knowledge of the ballistic problems that he is apt to encounter in the field as a battery commander. This problem was worked by all officers who took the January-February 1918 Course for Officers at the Coast Artillery School, Fort Monroe, Va. It is hoped that the following problem will help to clear up the gunnery principles involved, and will assist officers when studying the French methods of making the same corrections.

The complete problem with answers will appear in the next issue of the JOURNAL U. S. ARTILLERY.

Assumption.—You are assigned as Battery Commander to a battery of captured German guns. The Range Scales have been destroyed; in addition you are given a quantity of captured shells and powder charges for this particular gun.

Caliber 12-inch (railroad mount) gun.

Projectile—Weight 1070 lbs; Radius of Ogive 7 calibers.

Weight of powder charge, including igniter 334 lbs.

You are ordered to prepare data necessary for use of these guns.

PART I.

CONSTRUCTION OF RANGE TABLE. STEPS TO BE TAKEN:

(a) Fire a series of shots with captured ammunition through Chronograph Screens—Assume the M. V. thus determined to be 2250 f. s. Knowing the M. V. obtained, the angle of departure φ, the Range of the shots R, by correcting back to normal conditions of height of site, atmosphere, and wind, the value of the Ballistic Coefficient for the particular projectile can be determined.

In case no Chronograph Screen is available the approximate M. V. developed by the powder can be determined by firing a series of trial shots with a certain value of φ. Measure carefully the range of the shots "R", and correct back to normal conditions of height of site, atmosphere and wind. Assuming C as known, as in (b) following, an approximate value of M. V. can be obtained from Table II.

(b) Determine Ballistic Coefficient of projectile—Assume $i = .63$ for 7 cal.,—N. B. p12.

$$C = \frac{w}{id^2} = \frac{1070}{.63 \cdot 144} = 11.7945+.$$

$$\log C = 1.07167$$

(c) Compute a line of the Range Table for 5000; 10,000 and 15,000 yards, using table B and Table II. Tabulate results. (N. B. pp27-28).

Function	Formula	5000	10,000	15,000
Angle of Departure, φ	$\sin 2\varphi = AC$			
Time of flight, T	$T = \frac{CT'}{\cos\varphi}$			
Maximum Ordinate, Y_0	$Y_0 = 4.05T^2$			
Angle of Fall, ω	$\tan\omega = B' \tan\varphi$			
Slope of fall.	$\tan\omega = \frac{1}{x}$			
Remaining velocity, $V\omega$	$V\omega = \frac{u \cos\varphi}{\cos\omega}$			
Perforation of concrete.	$P_c = \frac{.0011475 wV\omega}{3r^2}$			
Perforation of sand.	$P_s = \frac{.0011475 wV\omega}{r^2}$			
Deflection 10 mile wind.	$d = \frac{W_y Z}{V} \cdot Dw^\circ$			
Drift.	$D = (1-K)\frac{d^3}{wn}(\varphi+\omega)\sec\varphi$			

(d) Graduate the Range Scales.

This can be done by computing the value of φ for every 200 yds. of range as in I(c) above. Then by means of a clinometer graduate the range scale. Interpolate between the 200 yard divisions.

PART II.

CONSTRUCTION OF RANGE CORRECTION CURVES.

NOTE.—The range table values found in Part I of this problem were computed under the following five main assumptions:

(a) That gun and target are on the same plane, and that the earth is flat.

(b) That the atmospheric density is normal, i. e., thermometer 15° C, barometer 750 mm, saturation 78 per cent.

(c) That there is no wind.

(d) That the muzzle velocity developed by the powder is standard, i. e. 2250 ft. seconds.

(e) That the form and weight of the projectile are standard, i. e. wt. = 1070 lbs., d = 12″, n = 7 cal.

Now in the field the above five assumptions upon which the Range Table has been computed and the range scale has been graduated will not hold true, but will change continually. We must, therefore, compute a set of correction curves (similar to the Pratt Range Correction Board), which will correct for deviations from the first four of the above assumptions. To avoid the use of plus and minus corrections, let us assume the following normal reference numbers: Height of Site 400, Atmosphere 16, Wind 50, Muzzle velocity 2250 f.s.

Correction Curves

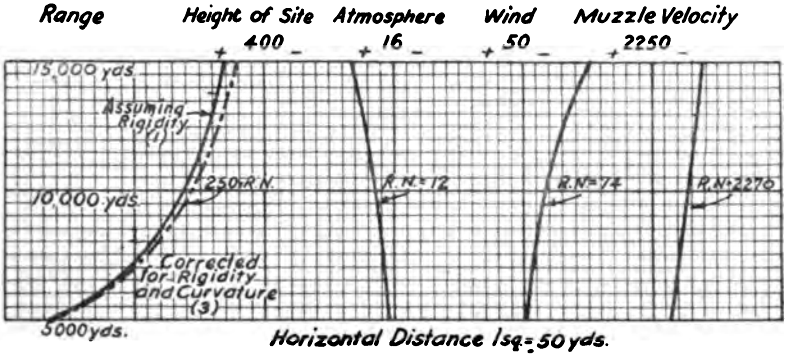


FIG. 1. 2172

(a) Correction for the first part of the first Range Table Assumption.

(1) That the gun and target are on the same plane.

Compute points on the correction curve for ranges of 5000, 10,000, and 15,000 yards, when the gun is 150 ft. below the target. Reference number: 400 − 150 = 250.

Method.—Assuming the theory of the rigidity of the trajectory.

φ = Range Table Value for Range R.

$$\text{Tan } \varepsilon = \frac{150}{3\text{ R}}$$

therefore,

$\varphi_1 = \varphi \pm \varepsilon$ (Depending on relation of gun and target).

From Range Table (part 1) find range R corresponding to φ.

From Range Table (part 1) find range R_1 corresponding to φ_1.

Therefore, *Range Correction* = $R_1 - R$.

(Plot this point on the height of site correction curve below).

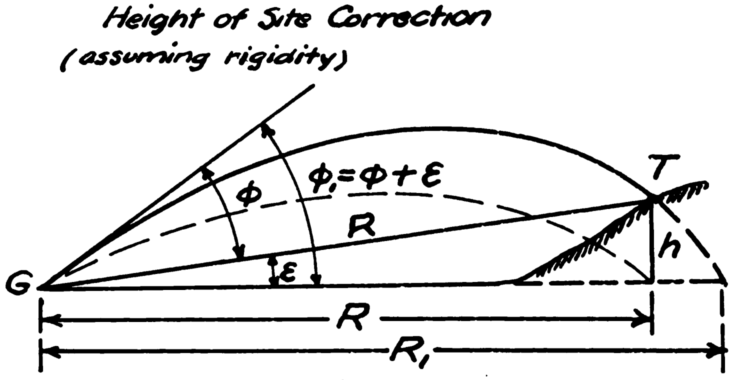


FIG. 2. 2173

Formula used when no range table is available:

$$\text{Sin } 2\varphi_1 = \text{AC or A} = \frac{\text{Sin } 2\varphi_1}{\text{C}}$$

From Table II, find corresponding value of Z for A and V.

$$\text{Now, Z} = \frac{X_1}{C} \text{ or } X_1 = CZ$$

Range correction = $X_1 - X$. Plot this point, (See Fig. 1).

Height of Site (Assuming Rigidity).

Function	Formula	5000	10,000	15,000
Angle of site ε	$\tan \varepsilon = \frac{h}{3R}$			
Q. A. D.	$\varphi_1 = \varphi \pm \varepsilon$			
A	$A = \frac{\sin 2\varphi_1}{C}$			
Z	Table II.			
X_1 (Range in ft.)	$X_1 = CZ$			
Range correction	$R_1 - R$			

(2) In the above solution we assumed the Theory of the Rigidity of the Trajectory. This Theory we know is not true and is corrected for by the French in what they term "The Complimentary Angle of Site." The error in the Theory of the Rigidity of the Trajectory can be shown graphically as follows:

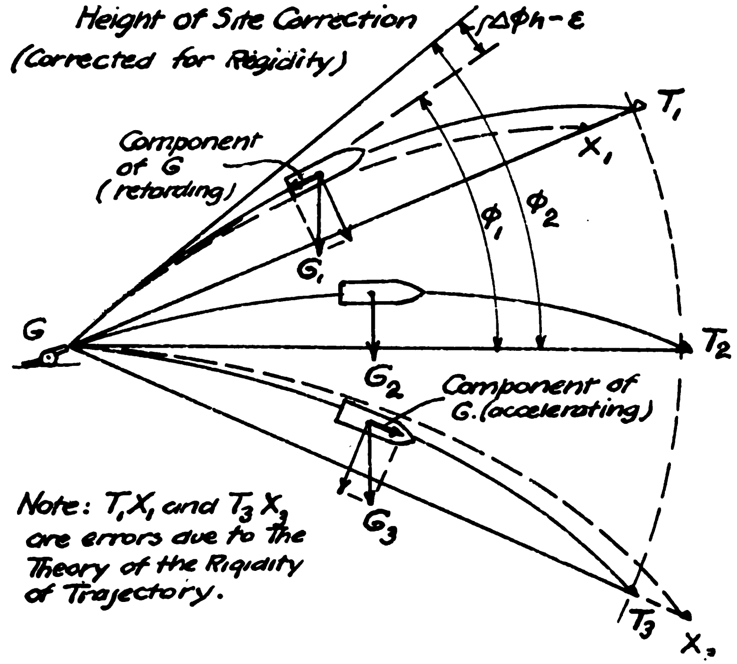

Height of Site Correction
(Corrected for Rigidity)
fΔφh − ε
T₁
X₁
Component of G (retarding)
φ₁
φ₂
G₁
G
T₂
G₂
Component of G. (accelerating)
G₃
Note: T₁X₁ and T₃X₃ are errors due to the Theory of the Rigidity of Trajectory.
T₃
X₃
2174

FIG. 3.

From the above Figure it can be seen that when the target is above the gun the projectile will fall short of the target due to the fact that the component of gravity is acting against the projectile. This will necessitate a plus correction in range or an increase in the angle of departure. When the target is below the gun the converse is true and the projectile will range beyond the target, requiring a decrease in the angle of departure. The French make this correction by use of the Complimentary Angle of Site tables, where the correction to be added or subtracted from the angle of site is given in degrees and minutes.

In our service it has been customary in the past to correct for the error in the Theory of the Rigidity of the Trajectory by means of the "F" Table. This checks approximately with the French Tables for direct fire. With high angle fire, however, the French Tables will probably be found more accurate, and will give greater corrections.

To use the "F" Tables, multiply the height of site (difference in level of gun and target in feet) by the expression $\frac{1134 + .005R}{R}$, where R equals the range in yards. The result will give the value of the angle of site in minutes corrected for error in the Theory of the Rigidity of the Trajectory.

HEIGHT OF SITE (CORRECTED FOR RIGIDITY)

Function	Formula	5000	10,000	15,000
F	$\frac{1134+.005R}{R}$			
ε corrected for rigidity $= \Delta\varphi_h$	$\Delta\varphi_h = Fh$			
Q. A. D.	$\varphi_2 = \varphi \pm \Delta\varphi_h$			
A	$A = \frac{\sin 2\varphi_2}{C}$			
Z	Table II.			
X_2 (Range in ft).	$X_2 = CZ$			
Range Correction	$R_2 - R$			

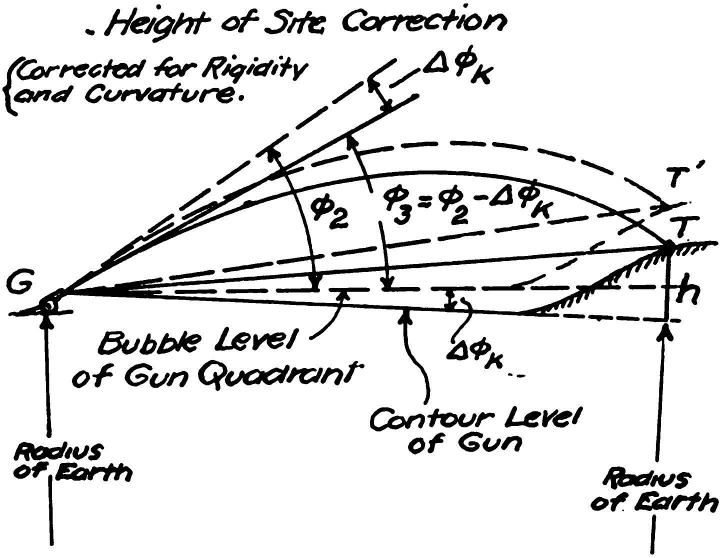


FIG. 4.

2175

(3) Correction for second part of the first Range Table Assumption, i. e., that the earth is flat, or that there is no curvature.

NOTE.—This correction is necessary when the difference in level between the gun and the target is determined from contours on a map. This correction is automatically made when determining difference in level between the gun and the target by means of a B. C. telescope, or other similar angular reading instrument, placed near the guns.

It will be noted that the correction for curvature is always negative.

In the above Figure $\varphi_3 = \varphi_1$ of Figure 2 corrected for curvature and rigidity.

or $\varphi_3 = \varphi \pm \Delta\varphi_h - \Delta\varphi_k$ where $\Delta\varphi_h$ is the correction for rigidity, and

$\Delta\varphi_k$ (curvature correction) in minutes is found from the expression $\Delta\varphi_k = \dfrac{R}{4000}$

K (curvature in feet) can be found from the expression $K = [3.3332619 - 10]\, R^2$, where R = Range.

Height of Site (Corrected for Rigidity and Curvature)

Function	Formula	5000	10,000	15,000
φ_2	$\varphi_2 = \varphi \pm \Delta\varphi_h$			
$\Delta\varphi_k$, curvature	$\Delta\varphi_k = \dfrac{R}{4000}$			
Q.A.D.	$\varphi_3 = \varphi_2 - \Delta\varphi_k$			
A	$A = \dfrac{\sin 2\varphi_3}{C}$			
Z	Table II.			
X_3 (range in ft).	$X_3 = CZ$			
Range Correction	$R_3 - R$			

Let us now tabulate the Range Corrections found in (1). (2) and (3) above and compare the results obtained.

Height of Site Correction	5000	10,000	15,000
Assuming Theory of Rigidity $\varphi_1 = \varphi \pm \varepsilon$			
Corrected for Rigidity $\varphi_2 = \varphi \pm \Delta\varphi_h$			
Corrected for Rigidity and Curvature $\varphi_3 = \varphi \pm \Delta\varphi_h - \Delta\varphi_k$			

See Problem 5, p. 18 and pp. 29-38, N. B.

The following method of determining the approximate range correction for height of site is sometimes used in the field:

Let x = Range Correction for Height of Site.
and ω = Angle of Fall

$$\text{Then } \tan\omega = \frac{h}{x}, \text{ or } x = \frac{h}{\tan\omega} = h \cot\omega$$

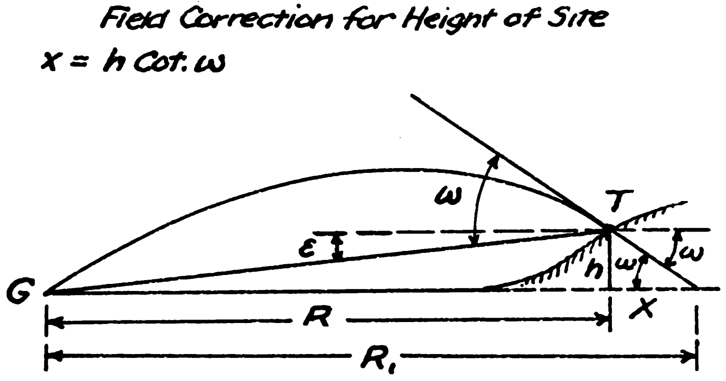


Fig. 5. 3176

Note.—It will be seen that this method is only a rough approximation as the angle of site is neglected.

(b) Correction for the second Range Table Assumption, i. e., that the atmosphere is normal, (temperature 15° C, barometer 750 mm., saturation 78 per cent.)

Compute points under atmosphere correction curve at ranges of 5000, 10,000 and 15,000 yards when the barometer reads 29″, and the thermometer reads 30°F.

Method:

From Table A, p. 57, we find $\frac{\delta_1}{\delta}$ = .96, which corresponds to a loss in the Ballistic Coefficient of 4 per cent.

Reference number would be, 16-4 or 12.

(Note.—Same reference number of 12 would be obtained by using Atmosphere Slide Rule for the above conditions).

Formula Used:

$$C_1 = \frac{w}{id^2} \cdot \frac{\delta_1}{\delta}$$

$Z = \frac{X}{C_1}$ Find from Table II corresponding value of A for Z and V.

$\sin 2\varphi_1 = AC_1$ Solve for φ_1.

From Range Table (Part 1) find range R corresponding to φ.

From Range Table (Part 1) find range R_1 corresponding to φ_1.

Therefore, Range Correction = $R_1 - R$.

Plot this point on the atmosphere correction curve Fig. 1.

NOTE.—In case no Range Table is available proceed as indicated in following Solution:

ATMOSPHERIC DENSITY

Function	Formula	5000	10,000	15,000
Ballistic Coef. of the Day	$C_1 = \frac{\delta_1}{\delta} C$			
Z	$Z = \frac{X}{C_1}$			
A_1	Table II.			
Q. A. D.	$\sin 2\varphi_1 = A_1C_1$			
A	$A = \frac{\sin 2\varphi_1}{C}$			
Z	Table II			
X_1	$X_1 = CZ$			
Range Correction	$R_1 - R$			

See Probs. 1, 2, 4, and 5 pp. 15 – 18 N. B and prob. 12, p. 40 N. B.

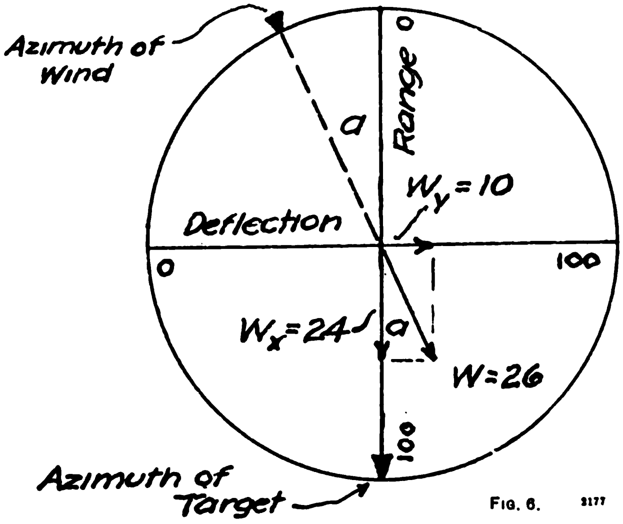


FIG. 6. 2177

(c) Correction for third Range Table Assumption, i. e., that there is no wind.

Compute points on the wind correction curve at ranges of 5000, 10,000 and 15,000 yards, when the azimuth of the wind is 168°, the azimuth of the target 10.62° and the velocity of the wind is 26 miles per hour.

Wind Component Indicator Relations.
$a = 22.62°$ $W = 26$ m per h.
$W_x = W \cos a = 24$ m per h.
$W_y = W \sin a = 10$ m. per h.
and, $W^2 = W_x^2 + W_y^2$

From Wind Component Indicator, $W_x = 24$ m. per h., therefore, Wind Reference Number $= 50 + 24 = 74$ (accelerating wind).

Formula Used:

$$C_1 = \frac{w}{id^2} \cdot f_w, \text{ where } f_w = 1 \pm \frac{2W_x T^{5/4}}{X}$$

$Z = \frac{X}{C_1}$, from table II, find corresponding value of A for Z and V.

$\sin 2\varphi_1 = AC_1$, solve for φ_1.

From Range Table (Part I) find range R corresponding to φ.

From Range Table (Part I) find range R_1 corresponding to φ_1.

Therefore, *Range Correction* $= R_1 - R$.

Plot this point on the Wind Correction Curve (See Fig. 1).

NOTE: In case no Range Table is available proceed as indicated in following solution:

WIND

Function	Formula	5000	10,000	15,000
Wind Factor,	$F = 1 \pm \frac{2W_x \cdot T^{5/4}}{X}$			
Bal. Coef. of the Day.	$C_1 = f_w C$			
Z	$Z = \frac{X}{C_1}$			
A_1	Table II			
Q. A. D.	$\sin 2\varphi_1 = A_1 C_1$			
A	$A = \frac{\sin 2\varphi}{C}$			
Z	Table II			
X_1	$X_1 = CZ$			
Range Correction	$R_1 - R$			

See probs. 1, 2, 4 and 5 pp. 15-18, N. B. and prob. 13 p. 42 N. B.

(d) Correction for fourth Range Table Assumption, i. e., that the Muzzle Velocity of the powder is standard, or 2250 f. s.

Compute points on the Muzzle Velocity Correction Curve at ranges of 5,000, 10,000 and 15,000 yards, for a Muzzle Velocity of 2270 f. s.

Reference Number 2270 f.s.

Formula Used:

$Z = \frac{X}{C}$, from Table II, find value of A_1 corresponding to Z and a Muzzle Velocity of 2270 f.s.

$\sin 2\varphi_1 = A_1C$, solve for φ_1.

From Range Table (Part I) find range R corresponding to φ.

From Range Table (Part I) find range R_1 corresponding to φ_1.

Therefore, *Range Correction* $= R_1 - R$.

Plot this point on the Muzzle Velocity Curve (see Fig. 1).

NOTE.—In case no Range Table is available proceed as indicated in following Solution:

MUZZLE VELOCITY

Function	Formula	5000	10,000	15,000
Z	$Z = \frac{X}{C}$			
A_1	Table II			
Q. A. D.	$\sin 2\varphi_1 = A_1.C$			
A	$A_1 = \frac{\sin 2\varphi_1}{C}$			
Z_1	Table II			
X_1	$X_1 = CZ_1$			
Range Correction	$R_1 - R$			

See probs. 4 and 5, pp. 18-19, N. B. and pp. 45-48, N. B.

PART III.

Construction of Deflection Correction Chart.

(a) Compute deflection correction curve for the same cross wind as determined from the Wind Component Indicator in Part II (c) of this problem, and for drift at ranges of 5000, 10,000 and 15,000 yards.

NOTE.—In firing at a stationary target, there are but two deflection corrections, wind and drift. Wind is a variable correction. Drift is always to the right, and is constant for the same range. We can, therefore, correct each wind deflection correction for any range by the constant drift correction for that same range—and thus correct for both wind and drift on the same curve. Remember the following rules:

R—R, To shoot right—Raise.
L—L, To shoot left—Lower. (Pp. 48-50, N. B.)

(1) Correction for Deflection Component of Wind. (P. 17, N. B.)

$$\text{Wind deflection (degrees)} = \frac{W_y Z}{V} . D^\circ_w$$

Where: W_y = 10 from Wind Comp. Ind., Part II (c).

$Z = \frac{X}{C}$ $V = \text{M.V.} = 2250$

D°_w is taken from Table D, (see p. 29).

Reference Number:

NOTE.—From Wind Component Indicator, Part II (c) the wind is blowing right to left, 10 mi. per hour. To hit target we must shoot right. To shoot right, Raise. Normal Reference Number = 50. Therefore, Reference Number = 50 + 10 = 60.

(2) Correction for Drift (p. 17, N. B.)

$$\text{Drift (degrees)} = (1 - K)\frac{d^2}{wn}(\varphi + \omega) \text{ Sec } \varphi.$$

where K (constant) = .75, and n (twist) = 25.

To obtain deflection correction, add algebraically 1 and 2 above.

Plot these corrections for 5000, 10,000 and 15,000 yards, and obtain a curve for the reference number 60.

DEFLECTION

Function	Formula	5000	10,000	15,000
Wind Deflection	$\frac{W_y Z}{V} . D^\circ_w \left(\frac{D}{\text{Table}}\right)$			
Drift	$D = (1 - K)\frac{d^2}{wn}$ $(\varphi + \omega)$ sec. φ			
Deflection (Wind and Drift Combined)	Add algebraically (1) and (2) above			

PART IV.

(a) Correction for variation in Muzzle Velocity due to a variation in weight of projectile. (p. 50, N. B.) Assume a lot of projectiles are received which are 4 pounds under standard weight. What change in Muzzle Velocity will result?

$$\Delta V = \frac{-7}{16} \frac{\Delta w}{w} V$$

Plot M. V. correction curve for variations of 2 lbs., 4 lbs., 6 lbs in weight of projectile.

It should be borne in mind that although the initial muzzle velocity will be greater with a lighter projectile, yet the value of the ballistic coefficient will be cut down, and the two will tend to compensate each other.

(b) Correction for variations in Muzzle Velocity due to variations in weight of powder charge. (P. 51, N. B.) Assume a lot of powder charges are received, which are 6 lbs. overweight. What change in Muzzle Velocity will result?

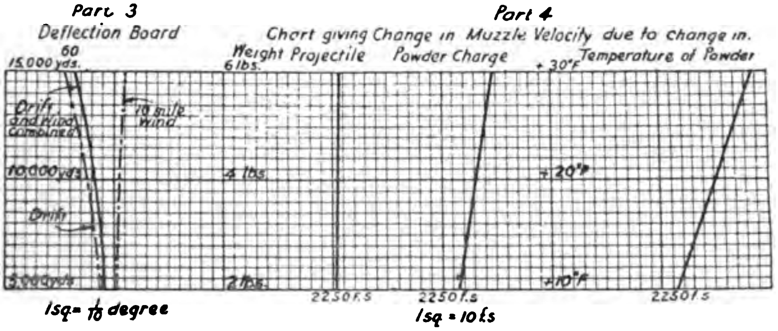


FIG. 7.

2178

$$\frac{V}{V_1} = \left(\frac{W}{W_1}\right)^y$$

Where y for smokeless powder = 1.2 and for nitroglycerine powder = 0.8. Plot M. V. correction curve for variations of 2 lbs., 4 lbs., 6 lbs., above standard weight of powder charge.

Function	Formula	Δ_w = 2 lbs.	Δ_w = 4 lbs.	Δ_w = 6 lbs.
Muzzle Velocity corrected for Weight of Projectile	$\Delta V = -\frac{7}{16} \cdot \frac{\Delta w}{w} V$			
Muzzle Velocity corrected for Weight of Powder	$\frac{V}{V_1} = \left(\frac{w}{w_1}\right)^y$			

(c) Correction for variation in temperature of powder charge. Assume temperature of powder magazine in which the powder has been stored for a period of two weeks is 80°F. What change in muzzle velocity will result? From the following table (taken from G. O. No. 5, W. D. 1910) we find a correction of + 24 f. s., or 2274 f.s.

NORMAL MUZZLE VELOCITES

F°	833	917	980	1056	1148	1220	2000	2100	2150	2200	2250	2400	2600
−10	27	30	32	34	38	40	65	67	69	71	72	77	84
0	26	29	31	33	37	39	63	66	67	69	70	75	81
+10	25	28	29	31	35	37	60	62	64	66	67	71	77
20	23	26	27	29	32	34	55	58	59	61	62	66	71
30	20	23	24	25	29	30	49	51	53	54	55	59	64
40	17	19	20	21	24	25	41	43	44	46	46	49	53
50	13	14	15	16	18	19	30	32	33	34	34	36	39
60	7	8	8	9	10	10	17	18	18	19	19	20	22
70	0	0	0	0	0	0	0	0	0	0	0	0	0
80	9	9	10	11	12	13	21	22	22	23	24	26	28
90	19	21	22	24	26	28	46	48	50	50	52	56	60
100	32	35	37	41	44	47	77	81	82	84	87	92	100

Deduct corrections for temperatures below 70°; add for above 70°. Plot M. V. correction curve due to temperature of powder charge of 80°F, 90°F and 100°F.

PART V.

Given a new U. S. Range Table, (tentative form), transfer data computed in parts I, II, III, and IV, of this problem to the new Range Table converting data into the French units of measure by means of the appended conversion table.

Data	Unit of Measure	5000	10,000	15,000
Range	Meters			
Angle of Departure	Mils			
dR for ± 1 mil El	Meters.			
dR for ± 10 m/s M. V.	"			
dR for ± 10 per cent of C	"			
dR for ± 1 kg. wt. of Proj.	"			
dR for ± 10 m/s Wind	"			
Drift	Mils			
Deflection for 10 m/s cross wind.	"			
Angle of Fall	"			
Slope of Fall	$^1/_x$			
Time of Flight	Seconds			
Maximum Ordinate	Meters			
Striking Velocity	Meters per sec.			
*Value of C	U.S. Units			

*A constant value of C was used in the above computations. This is only approximately true for direct fire. In high angle fire C will vary with the elevation and its value, as determined by experimental firing, will be given in the new range tables as a function of the range.

LINEAR AND ANGULAR MEASUREMENTS

The fundamental unit of the metric system is the meter. From this unit of length the units of capacity (liter), and weight (gram), are derived. All other units are the decimal subdivisions or multiples of these. These three units are related by the fact that 1 cubic decimeter equals 1 liter, and 1 liter of water at a standard temperature weighs 1 kilogram.

The metric tables are formed by combining the words "meter", "gram", and "liter" with the six numerical prefixes shown in the following table.

Prefix	Meaning	As. Com. Fra.	As Decimal	Units
Mili	One thous'th.	1/1000	.001	"Meter"
Centi	One hund'th	1/100	.01	for length
Deci	One tenth	1/10	.1	"Gram"
				for weight
Unit	One	1	1.	or mass.
Deka	Ten	10/1	10.	"Liter"
Hecto	One hundred	100/1	100.	for
Kilo	One thousand	1000/1	1000.	Capacity

The international meter = 39.37 inches, hence 1 yard = 3600/3937 meter. We will omit further reference to the gram (unit of weight and mass) and the liter (unit of capacity) since we are mainly concerned with the inter-relation of French and American units of linear measurements. In the absence of extended conversion tables the following conversion factors or constants will be found useful in transforming quantities from one unit or system to another.

Milimeters x .03937 = Inches
Inches x 25.400 = Millimeters

Meters x 3.280833 = Feet
Feet x .3048 = Meters

Kilometers x .621377 = Miles
Miles x 1.60935 = Kilometers

Temperature Conversion. F° and C°

Fahrenheit to Centigrade

$$5/9\,(F^\circ - 32) = C^\circ$$
$$9/5\,C^\circ + 32 = F^\circ$$

WEIGHT CONVERSION

Kilograms x 2.2046 = Pounds
Pounds x .4536 = Kilograms

Metric Tons x 1.1023 = Tons (2000 lbs)
(1000 kg.)
Tons (2000 lbs.) x .9072 = Metric Tons (1000 Kilograms)

ABBREVIATIONS (U. S. BUREAU OF STANDARDS):

Milimeter = mm
Centimeter = cm
Decimeter = dm

Meter =m
Dekameter =dkm
Hectometer =hm
Kilometer =km

Inch = in.
Foot = ft.
yard = yd.
Mile = mi.

1 Nautical or Sea Mile = 6080.20 ft. = 1.151533 mi. = 1853.249 meters.

This value is that established by the U. S. Coast and Geodetic Survey as being the length of 1 min. of arc of the great circle of a perfect sphere co-areal. It is ordinarily termed a knot.

CIRCULAR MEASURE

In what may be termed the American or customary system, the circle is considered as being divided into 360 primary divisions called degrees (°), and each degree into 60 minutes ($'$), and each minute into 60 seconds ($''$).

THE U. S. FIELD ARTILLERY MIL

The circle is divided into 6400 primary divisions called mils. The arc subtended by an angle of 1 mil is practically 1/1000 of the radius (range). The exact arc for an angle of 1 mil with a radius or range of 1000 meters is .98175 meters.

Hence the three rules:

1. Deflection angle in mils x $\frac{\text{Range in meters}}{1000}$ = Lateral deviation in meters.

2. Lateral deviation in meters ÷ $\frac{\text{Range in meters}}{1000}$ = Deflection in mils.

3. $\frac{\text{Lateral deviation in meters}}{\text{Deflection in mils}}$ x 1000 = Range in meters.

THE GRAD

The circle is divided into 400 primary units called grads (^{g}), and each grad into 10 decigrads, and each decigrad into 10 centesimal minutes ($'$). Each centesimal minute is divided into 100 centesimal seconds ($''$).

1 grad = 10 decigrads = 100 centesimal minutes = 10,000 centesimal seconds. 10 grads = 1 dekagrad.

Units	Inches	Feet	Yards	Miles	Centimeters	Meters
1 Inch =	1.	.083333	.027778	.000015783	2.540005	.025400
1 Foot =	12.	1.	.333333	.000189394	30.48006	.304801
1 Yard =	36.	3.	1.	.000568182	91.44018	.9144018
1 Mile =	63360.	5280.	1760.	1.	160934.72	1609.3472
1 cm =	.3937	.03280833	.0109361	.0000062137	1.	.01
1 Meter =	39.37	3.280833	1.0936111	.00062137	100.	1.

ANGULAR CONVERSION TABLE

Units	Degrees	Minutes	Seconds	Mils	Grads
1 Degree	1.	60.	3600.	17.7778	1.111111
1 Minute	.0166667	1.	60.	.296296	.0185185
1 Second	.00027778	.0166667	1.	.0049383	.000308642
1 Circle	360.	21600.	129600.	6400.	400.
1 Mil	.05625	3.375	202.5	1.	.0625
1 Grad	.9	54.	324.	16.	1.

The following tables, taken from "Notes on Ballistics," "Artillery Notes," and "Ingall's Table II, Artillery Circular M," have been added to complete this problem without reference to other works being necessary.

TABLE A

Values of δ_1/δ for temperature and pressure of atmosphere 78% saturated with moisture. (From *Artillery Note No. 25.*)

Ther. F.	Barometer 28″	29″	30″	31″	Ther. F.	Barometer 28″	29″	30″	31″
—20°	0.890	0.861	0.831	0.806	5°	0.942	0.909	0.880	0.851
—19°	0.892	0.863	0.833	0.808	6°	0.944	0.911	0.881	0.853
—18°	0.894	0.864	0.835	0.809	7°	0.946	0.913	0.883	0.855
—17°	0.896	0.866	0.837	0.811	8°	0.948	0.915	0.885	0.856
—16°	0.898	0.868	0.839	0.813	9°	0.950	0.917	0.887	0.858
—15°	0.901	0.870	0.841	0.815	10°	0.952	0.919	0.889	0.860
—14°	0.903	0.872	0.843	0.816	11°	0.954	0.921	0.890	0.862
—13°	0.905	0.874	0.845	0.818	12°	0.956	0.923	0.892	0.864
—12°	0.907	0.876	0.847	0.820	13°	0.958	0.925	0.894	0.866
—11°	0.910	0.878	0.848	0.822	14°	0.960	0.927	0.897	0.867
—10°	0.912	0.880	0.850	0.824	15°	0.962	0.929	0.899	0.869
— 9°	0.914	0.881	0.852	0.826	16°	0.964	0.931	0.901	0.871
— 8°	0.916	0.883	0.854	0.827	17°	0.966	0.933	0.903	0.873
— 7°	0.918	0.885	0.856	0.829	18°	0.968	0.935	0.905	0.875
— 6°	0.920	0.887	0.858	0.831	19°	0.971	0.937	0.907	0.877
— 5°	0.922	0.889	0.860	0.833	20°	0.973	0.939	0.909	0.879
— 4°	0.924	0.891	0.862	0.835	21°	0.975	0.941	0.911	0.881
— 3°	0.926	0.893	0.864	0.836	22°	0.977	0.943	0.912	0.883
— 2°	0.928	0.895	0.866	0.838	23°	0.979	0.945	0.914	0.885
— 1°	0.930	0.897	0.868	0.840	24°	0.981	0.947	0.916	0.887
0°	0.932	0.899	0.870	0.842	25°	0.983	0.949	0.918	0.888
1°	0.934	0.901	0.871	0.844	26°	0.985	0.951	0.920	0.890
2°	0.936	0.903	0.873	0.845	27°	0.987	0.953	0.922	0.892
3°	0.938	0.905	0.876	0.847	28°	0.990	0.955	0.924	0.894
4°	0.940	0.907	0.878	0.849	29°	0.992	0.958	0.926	0.896

TABLE A—Continued.

Ther.	Barometer				Ther.	Barometer			
F.	28″	29″	30″	31″	F.	28″	29″	30″	31″
30°	0.994	0.960	0.928	0.898	66°	1.073	1.035	1.001	0.968
31°	0.996	0.962	0.930	0.899	67°	1.075	1.037	1.003	0.970
32°	0.998	0.964	0.932	0.902	68°	1.078	1.040	1.005	0.973
33°	1.000	0.966	0.934	0.903	69°	1.080	1.042	1.007	0.975
34°	1.003	0.968	0.936	0.906	70°	1.082	1.044	1.009	0.977
35°	1.005	0.970	0.938	0.907	71°	1.085	1.046	1.011	0.979
36°	1.007	0.972	0.940	0.909	72°	1.087	1.048	1.013	0.981
37°	1.009	0.974	0.943	0.911	73°	1.089	1.050	1.015	0.983
38°	1.011	0.976	0.945	0.913	74°	1.092	1.053	1.017	0.985
39°	1.013	0.978	0.947	0.915	75°	1.094	1.055	1.019	0.987
40°	1.015	0.980	0.949	0.917	76°	1.096	1.057	1.022	0.989
41°	1.017	0.982	0.951	0.919	77°	1.099	1.059	1.025	0.992
42°	1.019	0.984	0.953	0.921	78°	1.101	1.062	1.027	0.994
43°	1.021	0.987	0.955	0.923	79°	1.104	1.064	1.029	0.996
44°	1.023	0.989	0.957	0.925	80°	1.106	1.066	1.031	0.998
45°	1.026	0.991	0.959	0.927	81°	1.109	1.068	1.033	1.000
46°	1.028	0.993	0.961	0.929	82°	1.111	1.071	1.035	1.002
47°	1.030	0.995	0.963	0.931	83°	1.114	1.074	1.038	1.005
48°	1.033	0.997	0.964	0.933	84°	1.116	1.076	1.041	1.007
49°	1.035	0.999	0.966	0.935	85°	1.119	1.079	1.043	1.009
50°	1.037	1.002	0.968	0.937	86°	1.121	1.081	1.045	1.011
51°	1.040	1.004	0.970	0.939	87°	1.124	1.083	1.047	1.013
52°	1.042	1.006	0.972	0.941	88°	1.126	1.086	1.049	1.016
53°	1.044	1.008	0.974	0.943	89°	1.129	1.089	1.053	1.018
54°	1.046	1.010	0.976	0.945	90°	1.131	1.092	1.055	1.020
55°	1.048	1.012	0.978	0.947	91°	1.134	1.094	1.057	1.022
56°	1.050	1.014	0.980	0.949	92°	1.136	1.096	1.059	1.025
57°	1.053	1.016	0.982	0.951	93°	1.139	1.099	1.062	1.027
58°	1.055	1.018	0.984	0.952	94°	1.142	1.102	1.064	1.029
59°	1.057	1.020	0.986	0.954	95°	1.144	1.105	1.066	1.031
60°	1.059	1.022	0.988	0.956	96°	1.147	1.107	1.068	1.033
61°	1.062	1.025	0.990	0.958	97°	1.149	1.110	1.071	1.035
62°	1.064	1.027	0.992	0.960	98°	1.152	1.112	1.074	1.037
63°	1.066	1.029	0.994	0.962	99°	1.155	1.115	1.076	1.040
64°	1.068	1.031	0.996	0.964	100°	1.157	1.117	1.079	1.042
65°	1.071	1.033	0.998	0.966					

TABLE B

(Taken from Ingalls' Table II, *Artillery Circular M*)

$V = 2200$ f.s.

$Z = \frac{X}{C}$	log B'	Δ_z	u	Δ_z	T'	Δ_z	log C'	Δ_z
							−10	
100	0.0036	36	2173	27	0.046	46	4.8266	35
200	0.0072	36	2146	26	0.092	47	4.8301	36
300	0.0108	37	2120	27	0.139	47	4.8337	36
400	0.0145	36	2093	26	0.186	48	4.8373	36
500	0.0181	37	2067	26	0.234	49	4.8409	37
600	0.0218	37	2041	26	0.283	49	4.8446	37
700	0.0255	37	2015	25	0.332	50	4.8483	37
800	0.0292	37	1990	26	0.382	51	4.8520	37
900	0.0329	37	1964	25	0.433	51	4.8557	38
1000	0.0366	38	1939	25	0.484	52	4.8595	38
1100	0.0404	37	1914	25	0.536	52	4.8633	39
1200	0.0441	38	1889	24	0.588	54	4.8672	39
1300	0.0479	37	1865	25	0.642	54	4.8711	39
1400	0.0516	38	1840	24	0.696	54	4.8750	39
1500	0.0554	38	1816	23	0.750	56	4.8789	39
1600	0.0592	38	1793	24	0.806	56	4.8828	40
1700	0.0630	38	1769	23	0.862	57	4.8868	40
1800	0.0668	38	1746	23	0.919	58	4.8908	40
1900	0.0706	39	1723	22	0.977	58	4.8948	41
2000	0.0745	38	1701	22	1.035	59	4.8989	41
2100	0.0783	38	1679	22	1.094	60	4.9030	41
2200	0.0821	39	1657	21	1.154	61	4.9071	41
2300	0.0860	38	1636	22	1.215	62	4.9112	42
2400	0.0898	38	1614	21	1.277	62	4.9154	41
2500	0.0936	38	1593	21	1.339	64	4.9195	42
2600	0.0974	38	1572	20	1.403	64	4.9237	42
2700	0.1012	38	1552	21	1.467	65	4.9279	43
2800	0.1050	38	1531	20	1.532	65	4.9322	42
2900	0.1088	38	1511	20	1.597	67	4.9364	43
3000	0.1126	38	1491	20	1.664	67	4.9407	43
3100	0.1164	38	1471	19	1.731	68	4.9450	43
3200	0.1202	38	1452	19	1.799	69	4.9493	43
3300	0.1240	37	1433	19	1.868	70	4.9536	43
3400	0.1277	38	1414	19	1.938	71	4.9579	44
3500	0.1315	38	1395	18	2.009	73	4.9623	44
3600	0.1353	37	1377	17	2.082	73	4.9667	44

TABLE B

(Taken from Ingalls' Table II, *Artillery Circular M*)

$V = 2200$ f.s.

$Z = \frac{X}{C}$	log B'	Δ_z	u	Δ_z	T'	Δ_z	log C'	Δ_z
							−10	
3700	0.1390	38	1360	18	2.155	74	4.9711	44
3800	0.1428	37	1342	17	2.229	75	4.9755	45
3900	0.1465	38	1325	16	2.304	76	4.9800	45
4000	0.1503	37	1309	16	2.380	77	4.9845	45
4100	0.1540	37	1293	16	2.457	78	4.9890	45
4200	0.1577	36	1277	16	2.535	78	4.9935	46
4300	0.1613	35	1261	15	2.613	80	4.9981	45
4400	0.1648	34	1246	14	2.693	81	5.0026	46
4500	0.1682	34	1232	14	2.774	81	5.0072	46
4600	0.1716	33	1218	14	2.855	83	5.0118	45
4700	0.1749	33	1204	13	2.938	83	5.0163	46
4800	0.1782	32	1191	12	3.021	85	5.0209	46
4900	0.1814	31	1179	12	3.106	85	5.0255	46
5000	0.1845	31	1167	12	3.191	86	5.0301	46
5100	0.1876	29	1155	11	3.277	87	5.0347	46
5200	0.1905	29	1144	10	3.364	88	5.0393	46
5300	0.1934	27	1134	11	3.452	89	5.0439	46
5400	0.1961	26	1123	10	3.541	89	5.0485	46
5500	0.1987	26	1113	10	3.630	90	5.0531	46
5600	0.2013	24	1103	9	3.720	91	5.0577	45
5700	0.2037	23	1094	9	3.811	92	5.0622	45
5800	0.2060	23	1085	9	3.903	93	5.0667	46
5900	0.2083	21	1076	8	3.996	93	5.0713	45
6000	0.2104	21	1068	8	4.089	94	5.0758	45
6100	0.2125	20	1060	8	4.183	95	5.0803	45
6200	0.2145	19	1052	7	4.278	96	5.0848	45
6300	0.2164	18	1045	8	4.374	96	5.0893	44
6400	0.2182	17	1037	7	4.470	97	5.0937	44
6500	0.2199	17	1030	7	4.567	97	5.0981	44
6600	0.2216	16	1023	7	4.664	98	5.1025	44
6700	0.2232	16	1016	6	4.762	99	5.1069	43
6800	0.2248	14	1010	7	4.861	99	5.1112	43
6900	0.2262	14	1003	6	4.960	100	5.1155	43
7000	0.2276	13	997	6	5.060	101	5.1198	43

TABLE B

(Taken from Ingalls' Table II, *Artillery Circular M*)

$V = 2300$ f.s.

$Z = \frac{X}{C}$	og B'	Δ_z	u	Δ_z	T'	Δ_z	log C'	Δ_z
							−10	
100	0.0036	35	2272	28	0.044	44	4.7878	35
200	0.0071	36	2244	28	0.088	45	4.7913	35
300	0.0107	36	2216	27	0.133	45	4.7948	36
400	0.0143	36	2189	27	0 178	46	4.7984	36
500	0.0179	36	2162	27	0.224	47	4.8020	36
600	0.0215	36	2135	27	0.271	47	4.8056	37
700	0.0251	36	2108	26	0.318	48	4.8093	37
800	0.0287	37	2082	26	0.366	48	4.8130	37
900	0.0324	37	2056	26	0.414	49	4.8167	37
1000	0.0361	37	2030	26	0.463	50	4.8204	38
1100	0.0398	37	2004	25	0.513	50	4.8242	38
1200	0.0435	37	1979	25	0.563	51	4.8280	38
1300	0.0472	37	1954	25	0.614	51	4.8318	38
1400	0.0509	37	1929	25	0.665	52	4.8356	39
1500	0.0546	38	1904	25	0.717	53	4.8395	39
1600	0.0584	37	1879	24	0.770	54	4.8434	39
1700	0.0621	38	1855	24	0.824	54	4.8473	39
1800	0.0659	38	1831	24	0.878	55	4.8512	40
1900	0.0697	38	1807	23	0.933	56	4.8552	40
2000	0.0735	38	1784	23	0.989	56	4.8592	40
2100	0.0773	38	1761	23	1.045	57	4.8632	41
2200	0.0811	38	1738	23	1.102	58	4.8673	40
2300	0.0849	38	1715	22	1.160	59	4.8713	41
2400	0.0887	38	1693	22	1.219	60	4.8754	42
2500	0.0925	38	1671	22	1.279	60	4.8796	41
2600	0.0963	39	1649	22	1.339	61	4.8837	42
2700	0.1002	38	1627	21	1.400	62	4.8879	42
2800	0.1040	38	1606	21	1.462	63	4.8921	42
2900	0.1078	39	1585	21	1.525	63	4.8963	42
3000	0.1117	38	1564	21	1.588	64	4.9005	42
3100	0.1155	37	1543	20	1.652	65	4.9047	43
3200	0.1192	38	1523	20	1.717	66	4.9090	43
3300	0.1230	38	1503	20	1.783	67	4.9133	43
3400	0.1268	38	1483	19	1.850	68	4.9176	44
3500	0.1306	38	1464	19	1.918	69	4.9220	44
3600	0.1344	38	1445	19	1.987	70	4.9264	44

TABLE B

(Taken from Ingalls' Table II, *Artillery Circular M*)

$V = 2300$ f s.

$Z = \frac{X}{C}$	log B'	Δ_z	u	Δ_z	T'	Δ_z	log C'	Δ_z
							−10	
3700	0.1382	38	1426	19	2.057	70	4.9308	44
3800	0.1420	38	1407	18	2.127	71	4.9352	44
3900	0.1458	38	1389	18	2.198	73	4.9396	45
4000	0.1496	38	1371	18	2.271	73	4.9441	45
4100	0.1534	38	1353	18	2.344	74	4.9486	45
4200	0.1572	38	1335	17	2.418	76	4.9531	45
4300	0.1610	37	1318	17	2.494	76	4.9576	45
4400	0.1647	36	1301	16	2.570	77	4.9621	46
4500	0.1683	36	1285	16	2.647	78	4.9667	46
4600	0.1719	35	1269	15	2.725	79	4.9713	46
4700	0.1754	35	1254	15	2.804	81	4.9759	46
4800	0.1789	34	1239	14	2.885	81	4.9805	46
4900	0.1823	34	1225	13	2.966	82	4.9851	46
5000	0.1857	34	1212	13	3.048	83	4.9897	46
5100	0.1891	33	1199	12	3.131	84	4.9943	47
5200	0.1924	32	1187	12	3.215	85	4.9990	46
5300	0.1956	31	1175	12	3.300	86	5.0036	47
5400	0.1987	30	1163	12	3.386	87	5.0083	46
5500	0.2017	29	1151	11	3.473	87	5.0129	47
5600	0.2046	28	1140	10	3.560	88	5.0176	46
5700	0.2074	26	1130	11	3.648	89	5.0222	47
5800	0.2100	26	1119	10	3.737	90	5.0269	46
5900	0.2126	25	1109	9	3.827	90	5.0315	47
6000	0.2151	24	1100	9	3.917	91	5.0362	47
6100	0.2175	23	1091	9	4.008	92	5.0409	47
6200	0.2198	22	1082	9	4.100	93	5.0456	46
6300	0.2220	22	1073	8	4.193	94	5.0502	46
6400	0.2242	20	1065	8	4.287	94	5.0548	46
6500	0.2262	20	1057	8	4.381	95	5.0594	45
6600	0.2282	19	1049	8	4.476	95	5.0639	46
6700	0.2301	18	1041	7	4.571	96	5.0685	45
6800	0.2319	17	1034	7	4.667	97	5.0730	44
6900	0.2336	16	1027	7	4.764	98	5.0774	45
7000	0.2352	15	1020	6	4.862	99	5.0819	45

TABLE C

(From *Ballistics*, Part I, Hamilton)

Values of the coefficient of form, for projectiles the heads of which are of ogival radius n calibers.

n	c
2	1.00
3	0.82
4	0.71
5	0.64
6	0.58
7	0.54

NOTE: Assumed value of i = .63 for 12-inch long-pointed projectile.

TABLE D

(From *Ballistics*, Part I, Hamilton)

Values of D_w in degrees, for use with the formula,

$$\text{Deflection for } W \text{ mile wind} = \frac{W_y Z}{V} \,.\, D_w^\circ$$

V	1600	1700	1800	1900	2000	2100
Z	°	°	°	°	°	°
0000	.0055	.0055	.0055	.0054	.0054	.0053
1000	.0059	.0058	.0058	.0057	.0057	.0056
2000	.0061	.0060	.0061	.0060	.0060	.0059
3000	.0061	.0062	.0063	.0063	.0063	.0062
4000	.0060	.0062	.0063	.0065	.0065	.0065
5000	.0059	.0061	.0064	.0066	.0067	.0067
6000	.0057	.0061	.0065	.0066	.0068	.0069
7000	.0055	.0060	.0064	.0065	.0068	.0070
8000	.0054	.0059	.0062	.0064	.0067	.0070
9000	.0053	.0057	.0060	.0063	.0066	.0069
10000	.0052	.0056	.0059	.0062	.0066	.0069
11000	.0051	.0055	.0058	.0061	.0065	.0068
12000	.0051	.0054	.0058	.0061	.0064	.0067
13000	.0050	.0054	.0057	.0061	.0063	.0067
14000	.0050	.0053	.0057	.0060	.0062	.0066
15000	.0049	.0053	.0056	.0059	.0062	.0065
16000	.0049	.0053	.0056	.0059	.0062	.0065
17000	.0049	.0052	.0055	.0058	.0061	.0064
18000	.0049	.0052	.0055	.0058	.0061	.0064
19000	.0048	.0052	.0055	.0057	.0060	.0063
20000	.0048	.0051	.0054	.0057	.0060	.0063
21000	.0048	.0051	.0054	.0057	.0060	.0062

TABLE D—Continued.

V	2100	2200	2300	2400	2500	2600
Z	°	°	°	°	°	°
0000	.0053	.0052	.0051	.0050	.0049	.0048
1000	.0056	.0056	.0055	.0054	.0053	.0052
2000	.0059	.0059	.0058	.0057	.0056	.0055
3000	.0062	.0062	.0061	.0060	.0059	.0059
4000	.0065	.0065	.0064	.0063	.0063	.0063
5000	.0067	.0068	.0067	.0067	.0067	.0067
6000	.0069	.0070	.0070	.0070	.0070	.0070
7000	.0070	.0071	.0072	.0072	.0072	.0072
8000	.0070	.0071	.0072	.0073	.0074	.0074
9000	.0069	.0071	.0072	.0074	.0075	.0076
10000	.0069	.0072	.0072	.0074	.0075	.0076
11000	.0068	.0070	.0071	.0073	.0075	.0076
12000	.0067	.0069	.0071	.0073	.0075	.0076
13000	.0067	.0069	.0071	.0073	.0074	.0076
14000	.0066	.0068	.0070	.0072	.0074	.0076
15000	.0065	.0068	.0070	.0072	.0074	.0076
16000	.0065	.0067	.0069	.0072	.0073	.0075
17000	.0064	.0067	.0069	.0071	.0073	.0075
18000	.0064	.0067	.0069	.0071	.0073	.0075
19000	.0063	.0066	.0069	.0071	.0073	.0075
20000	.0063	.0066	.0068	.0071	.0073	.0075
21000	.0062	.0065	.0068	.0071	.0073	.0075

V	2600	2700	2800	2900	3000	3100
Z	°	°	°	°	°	°
0000	.0048	.0048	.0047	.0047	.0046	.0046
1000	.0052	.0051	.0050	.0050	.0049	.0048
2000	.0055	.0054	.0054	.0053	.0052	.0051
3000	.0059	.0058	.0057	.0056	.0055	.0054
4000	.0063	.0062	.0060	.0060	.0059	.0058
5000	.0067	.0066	.0064	.0063	.0063	.0062
6000	.0070	.0069	.0068	.0067	.0066	.0065
7000	.0072	.0072	.0072	.0071	.0070	.0069
8000	.0074	.0075	.0075	.0074	.0074	.0073
9000	.0076	.0077	.0077	.0077	.0077	.0077
10000	.0076	.0077	.0078	.0078	.0079	.0079
11000	.0076	.0078	.0079	.0079	.0080	.0081
12000	.0076	.0078	.0079	.0080	.0081	.0082
13000	.0076	.0078	.0079	.0080	.0081	.0082
14000	.0076	.0078	.0079	.0081	.0082	.0083
15000	.0076	.0078	.0079	.0081	.0082	.0083
16000	.0075	.0077	.0079	.0081	.0082	.0083
17000	.0075	.0077	.0079	.0081	.0082	.0084
18000	.0075	.0077	.0079	.0081	.0082	.0084
19000	.0075	.0077	.0079	.0081	.0083	.0084
20000	.0075	.0077	.0079	.0081	.0083	.0084
21000	.0075	.0077	.0079	.0081	.0083	.0084

TABLE D—Continued

V	3100	3200	3300	3400	3500	3600
Z	°	°	°	°	°	°
0000	.0046	.0045	.0045	.0044	.0044	.0043
1000	.0048	.0047	.0047	.0046	.0046	.0045
2000	.0051	.0050	.0050	.0049	.0048	.0047
3000	.0054	.0053	.0053	.0052	.0051	.0050
4000	.0058	.0057	.0057	.0056	.0055	.0053
5000	.0062	.0061	.0060	.0059	.0058	.0056
6000	.0065	.0064	.0063	.0062	.0061	.0060
7000	.0069	.0068	.0067	.0066	.0065	.0064
8000	.0073	.0072	.0071	.0070	.0069	.0068
9000	.0077	.0076	.0075	.0075	.0073	.0073
10000	.0079	.0079	.0078	.0078	.0077	.0077
11000	.0081	.0081	.0081	.0081	.0080	.0080
12000	.0082	.0082	.0083	.0083	.0083	.0083
13000	.0082	.0083	.0084	.0084	.0085	.0085
14000	.0083	.0084	.0085	.0085	.0086	.0086
15000	.0083	.0084	.0085	.0086	.0087	.0088
16000	.0084	.0085	.0086	.0086	.0087	.0088
17000	.0084	.0085	.0086	.0087	.0088	.0089
18000	.0084	.0085	.0087	.0088	.0089	.0090
19000	.0084	.0086	.0087	.0088	.0089	.0090
20000	.0084	.0086	.0087	.0089	.0090	.0091
21000	.0084	.0086	.0087	.0089	.0090	.0091

TABLE E

(From *Ballistics,* Part I, Hamilton)

Table of values of percentage changes in muzzle velocity of powders tested at 70° F. and fired with a magazine temperature $t°$ F.

t	$\Delta V/V$	ΔV for $V =$		
		2000	2250	2500
0°	−.0323	−65	−73	−81
10°	−.0302	−60	−67	−75
20°	−.0275	−55	−62	−69
30°	−.0241	−48	−54	−60
40°	−.0199	−40	−45	−50
50°	−.0147	−29	−33	−36
60°	−.0082	−16	−18	−20
70°	−.0000	0	0	0
80°	.0101	20	23	25
90°	.0228	46	52	58
100°	.0387	77	87	96

DIAGRAMS SHOWING SIMILARITY OF COAST ARTILLERY GUNNERY TO HEAVY ARTILLERY GUNNERY.

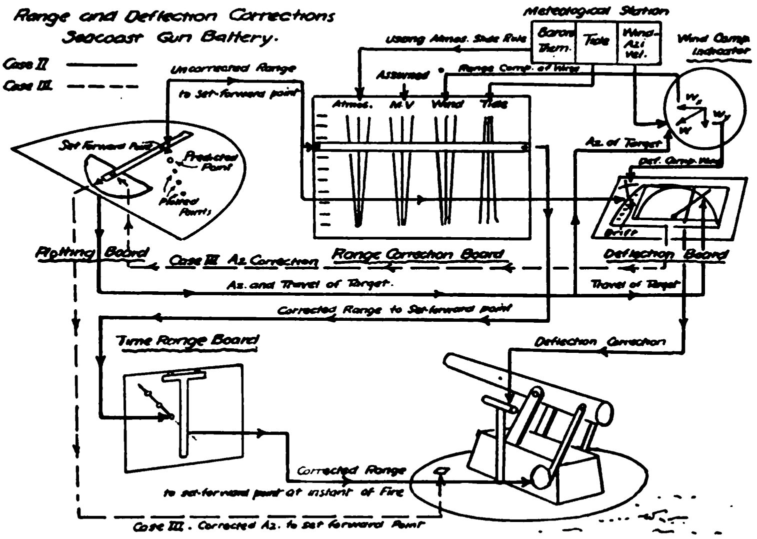


FIG. 8.

2179

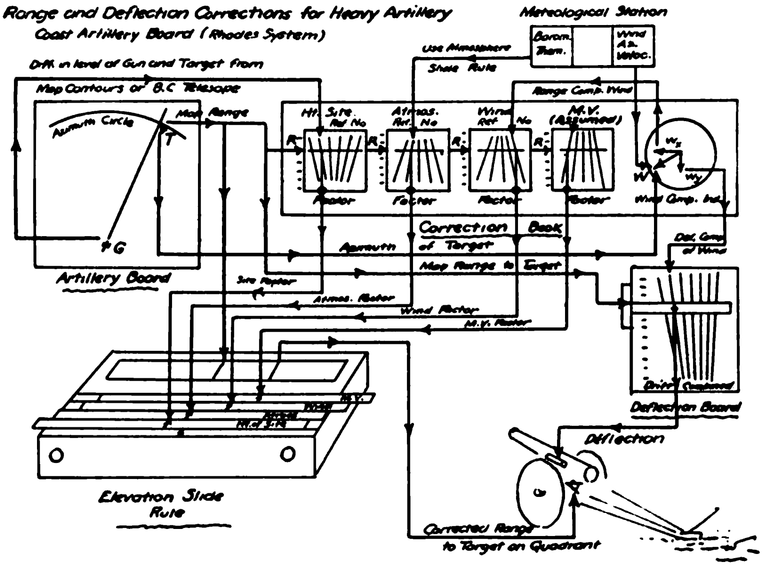


FIG. 9.

2180

Conversion Table
for
Angular Measurements Used in Artillery Work.

NOTE: The following tables will be found accurate to three significant figures, except Table III, which is computed to four significant figures on account of the greater value of the unit of argument.

Intermediate values may be found by summation: thus to convert 122°47′ into decigrades, proceed as follows:

100° = 1111.
20° = 222.2
2° = 22.2
30′ = 5.6
17′ = 3.1

1364 decigrades

The totals will be accurate to the same place as the largest component; residuals should be carried as above.

TABLE I

Mils	Degrees	Min.	Decigrades
1	.0563	3.38	.625
2	.113	6.75	1.25
3	.169	10.1	1.88
4	.225	13.5	2.50
5	.281	16.9	3.13
6	.338	20.3	3.75
7	.394	23.6	.438
8	.450	27.0	5.00
9	.506	30.4	5.63
10	.563	33.8	6.25
20	1.13	67.5	12.5
30	1.69	101.	18.8
40	2.25	135.	25.0
50	2.81	169.	31.3
60	3.38	203.	37.5
70	3.94	236.	43.8
80	4.50	270.	50.0
90	5.06	304.	56.3
100	5.63	338.	62.5

TABLE II

Decigrades	Min.	Degrees	Mils
1	5.40	.090	1.60
2	10.8	.180	3.20
3	16.2	.270	4.80
4	21.6	.360	6.40
5	27.0	.450	8.00
6	32.4	.540	9.60
7	37.8	.630	11.2
8	43.2	.720	12.8
9	48.6	.810	14.4
10	54.0	.900	16.0
20	108.	1.80	32.0
30	162.	2.70	48.0
40	216.	3.60	64.0
50	270.	4.50	80.0
60	324.	5.40	96.0
70	378.	6.30	112.
80	432.	7.20	128.
90	486.	8.10	144.
100	540.	9.00	160.

TABLE III

Degrees	Mils	Decigrades
1	17.78	11.11
2	35.56	22.22
3	53.33	33.33
4	71.11	44.44
5	88.89	55.56
6	106.7	66.67
7	124.4	77.78
8	142.2	88.89
9	160.0	100.00
10	177.8	111.1
20	355.6	222.2
30	533.3	333.3
40	711.1	444.4
50	888.9	555.6
60	1067.	666.7
70	1244.	777.8
80	1422.	888.9
90	1600.	1000.
100	1778.	1111.

TABLE IV

Min.	Degrees	Mils	Decigrades
1	.0167	.296	.185
2	.0333	.592	.370
3	.0500	.888	.556
4	.0667	1.18	.741
5	.0833	1.48	.926
6	.1000	1.78	1.11
7	.117	2.07	1.30
8	.133	2.37	1.48
9	.150	2.66	1.67
10	.167	2.96	1.85
11	.184	3.26	2.04
12	.200	3.55	2.22
13	.217	3.85	2.41
14	.234	4.15	2.59
15	.250	4.44	2.78
16	.267	4.74	2.96
17	.284	5.03	3.15
18	.300	5.33	3.33
19	.317	5.62	3.52
20	.333	5.92	3.70
21	.350	6.22	3.89
22	.367	6.52	4.08
23	.384	6.81	4.26
24	.400	7.10	4.45
25	.417	7.40	4.63
26	.433	7.70	4.82
27	.450	8.00	5.00
28	.467	8.30	5.19
29	.483	8.59	5.37
30	.500	8.89	5.56

With a Trench Mortar Battery on the French Front

Traduction and Commentary by George Nestler Tricoche, formerly of the French Artillery

(The following extracts were taken from a book by Mr. Paul Duval-Arnould, and entitled "CRAPOUILLOTS; Feuillets d'un Carnet de Guerre." (Leaflets from a war note-book).[1]

Crapouillot, in French war slang, is a familiar name for trench mortar; it is extended also to the men who serve such a gun. The name is derived from "Crapeau" (toad), and alludes to the batrachian-like appearance of this mortar, especially when loaded. Lieutenant Arnould's volume is not a diary, but a collection of anecdotes written chiefly for the general public. Yet so little is known—comparatively—in the United States, about the Trench branch of the Artillery, its use and tactics, that, at the present time, details about *Crapouillots* might be welcome, even when they are not strictly scientific. At any rate, we have deemed it appropriate to complete our commentary upon some passages of these extracts by particulars taken from a paper that appeared in the August, 1917, issue of the *Revue Militaire Suisse*, under the caption "Artillerie de Tranches," and written by E. Van Erde, of the Belgian Army. Lieutenant Van Erde is not a stranger to the readers of the FIELD ARTILLERY JOURNAL, for some of his notes on the field batteries of his country have been used in our January number ("Contemporaneous Notes on Belgian Artillery").

The author first introduces his gun to us, and the description is well worth quoting:

> Do you spy out, into that bent of the trench, that diminitive field gun? Does it not look like a beautiful plaything just brought in from a toy shop? Its bluish robe is brand new; the flat edge of its tiny jaw shines in the sun and seems to smile to Life and Light. The whole affair gives the impression of something fine and smart: it reminds one of the tree frog, the pretty batrachian of our meadows: it is our *crapouillot*. But oh, what is this

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[1] Plon-Nourrit, Editors, Paris.

sudden metamorphosis? The cannoneers have loaded the gun: enormous, heavy, blackish, the torpedo emerges, entire, from the tube. The toy has turned into a hidious reptile; some kind of formidable crotalus, coiling up, sticking out its horrid head that is armed with a beak, and striated with three crests. . . . A little grease patters at the muzzel and is dripping along the tube—a blackish, stinking drivel. . . .

It must be remembered that the peculiar way of loading this mortar—the placing of the projectile *outside* of the tube—was an improvement upon the first type of trench artillery. In the early models of trench gun, the shell or torpedo was about normal in respect to the calibre of gun used; it was placed inside the tube as usual. But in order to obtain a very short trajectory the propelling charge had been considerably reduced. All this had serious drawbacks: *First,* it was impossible to use, with such guns, projectiles heavy enough to produce the crushing effects needed at close range. *Second,* the tube was too long, and uneasy to handle in narrow trenches.[1] *Third,* the powder's properties had been determined by experiments under normal pressure conditions—for instance, 2000 kilogrammes per each square centimetre: with a pressure ten times smaller, new and unknown conditions presented themselves; the deflagration became somewhat erratic, causing hang-fires, wild trajectories, and therefore endangering the lives of near-by friendly troops and gun crews themselves. If we stop to think how dangerous the latest types of trench mortars are, sometimes, for men in the neighboring trenches, we may form an approximate idea of conditions at the birth of that kind of artillery. These conditions were even worse than in the Middle Ages, when pieces somewhat similar were in service, because, then, powder was always used in a normal way, so to speak.

To remedy these defects, it has been decided to come back to a normal propelling charge, but, on the other hand, to increase the weight of the projectile. Small, short mortars are now used and the torpedo is practically outside of the tube.

One of the advantages of this way of loading is that the "small wings"[2] or fin-like appendages, which are used to steady the torpedo during its flight, are no more liable to be

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[1] Besides, the propelling charge being much reduced, it had seemed ad- save metal by making the tubes thinner but it soon became obvious with that diminished amount of powder and gasses, the inside be deteriorated quickly; accidents became frequent.

s, in French,

broken or bent in the tube of the gun at the time of the discharge. Not only the danger from premature bursts and erratic trajectories is considerably lessened and the fire accuracy and efficiency much improved, but the trench mortar has become much less cumbersome and can be easily moved from place to place.

But let us go back to the book. From some pages, more or less disfigured by the censor, we may infer that it was not an easy task, at first, to organize and drill the trench mortar batteries.

Speaking of the baptism of fire of his own unit, Lieutenant Arnould says:

> . . . Fifteen days ago we hardly knew one another; we had never seen our weapon. But in wartime, in France, it does not take long to do things right, especially with Poilus such as ours.

It seems that, at the beginning, the personnel was somewhat heterogeneous and hard to manage. In describing his captain's personality, the author says:

> . . . It was certainly a difficult thing to "build up" that battery and give it the needed degree of efficiency. Personnel, matériel, chiefs, all had to be transformed. He succeeded, by dint of firmness, diplomacy; but had it not been for his robustness, he would have lost his health and courage in the undertaking. . . .

Here the censor cut off what was obviously a scene anything but edifying as regards discipline; the last paragraph of the narative reads thus:

> . . . Like a professional lion tamer, the captain appeased them with a few words, brief and to the point; he turned them into a flock, still grumbling, of course, but which stoically, that day, made up its mind to obey without further ado. Since, he made heroes out of them.

We can understand this condition of things, unusual in the French Army of to-day, if we remember the genesis of that branch of the arm. Trench artillery in France had been created by a certain general who was allowed to experiment on a very limited scale with a few platoons. The personnel of the new service numbered only about 180 officers and men. The remarkable success of this venture caused the hasty formation of a number of batteries, the personnel of which had to be taken from other field artillery organizations. It seems that, as customary in such cases, the new service was not, at first, very popular, and, although we have no positive proof of our assertion, we are inclined to believe that regimental commanders took this opportunity to get rid of what they considered undesirable elements. We had seen a similar condition of things, personally, in 1883, when the Fortress Artillery was first organized in France.

> Who they were when we first met? Well, they were "all kinds": veterans who had been forgotten in the trenches for months; who had seen the birth of the new arm; who had handled bronze guns and fired wooden torpedoes; also men whom a natural craving for freedom, action, and an adventurous life had prompted to volunteer for this service. Lastly, some fellows soured by their military experiences, who had rebelled against inconsiderate or misunderstood orders and been courtmartialled.
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> A motley crowd in which the best and the worst elements are side by side; a body of soldiers which at first conveys to one's mind grave misgivings, sometimes, in the evening after a battle, causes its chief to thrill with pride.

Be it as it may, the fact remains that the *crapouillots,* at the time this book was written, were not particularly popular among artillerymen, while, on the other hand, infantry men admired and treated them with much consideration. This ludicrous condition of things, which can be observed throughout the book, is easy to understand, for trench mortar's work is so closely related to that of the infantry that the latter alone is generally able to appreciate it at its full value. To the ordinary field artillerist the new branch appears like a mongrel, doomed to an ephemeral existence and using obsolete contrivances. Yet this and the peculiar recruiting of the new units are not the only causes of the attitude of the ordinary artilleryman toward his young brother of the trenches. The *crapouillot* is a favorite with divisional and brigade commanders—with all general officers, in fact. He fights at close range and accomplishes, almost out of necessity, daring deeds, that make him conspicuous and give him an enviable position in the army. Hence some jealousy, which, at times, manifests itself by some nagging and, even, unfairness. The following extracts give a rather amusing instance of it:

> When our first winter was at last at an end, a wise General Order prescribed to all unit commanders to build immediately comfortable stables for their respective horses. . . . They had only to fill requisition blank for the material and great many other blanks and forms; also to use a great deal of patience, and they would finally obtain everything they needed.

The battery commander, a "territorial" detailed with the *crapouillots* and in civil life an inspector for an insurance company, was a very active man, with some "pull."

It was not long before he had all the boards and tar paper necessary for his command.

. . . Fifteen days later, all our horses were eating out of regular troughs, in a sort of hangar consisting chiefly of a roof, and built in the shape of a horseshoe. The stables were completed by large store-rooms for feed and a beautiful portable saddle-room, an object of especial pride for our *adjutant*. . . .

The latter is a kind of battery sergeant major, ranking above the first sergeant. The care of saddles, harnesses, etc., is one of his duties.

. . .Some people could not reconcile themselves at all with that achievement. I allude to our neighbors in that cantonment: the field batteries.

They were turning yellow with envy at seeing our horses get fatter and stronger every day, while their goat-like mounts were still "drying up" at the horse line.

The "top veterinarian"[1] set us as an example all over the country for twenty leagues around; and from a distance of twenty leagues people came to see the *crapouillots*' stable. . . .

But said *crapouillots* were reckoning without the major of the neighboring field artillery battalion, whose visits to the stable became too frequent not to be, finally, alarming.

. . . One morning an order came, explaining that the artillery cantonment had become suddenly too cramped, and, to remedy this situation, the trench mortar battery was to move out into the open fields, to some earthen hovels, half destroyed by rain water and which, vacated for about six months, were alive with rats and lice. . . . .

The battery commander did not allow himself to be crestfallen at this news. He went, on the sly, to the general who had created the new branch of the arm, and, after the interview, came back smiling in a strange manner.

. . . At about 6 o'clock, the major, happening to meet our captain . . . said to him something like this: "By the way, you are leaving to-morrow. I need that cantonment of yours by 8 A.M. As I have no great confidence in your *crapouillots*, and as, on account of the general, I want to have a very clean cantonment, you will please satisfy yourself personally that not the slightest bit of horse dung remains there—you understand me: not a bit." . . .

Here ends the drama and the comedy begins, for, taking advantage of a dark, rainy night, the French cannoneers took the stables to pieces, while the drivers, in many hurried trips, carried boards and all material to the new cantonment's site.

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[1] This refers evidently to the Veterinarian Inspector. The author's expression is: "La grosse huile vétérinarie." *Huile* (oil) in army slang means any high officer. A *grosse huile* (big oil) is generally an army corps or army commander. There are many shades of meaning in the slangy terms which are lavishly used by the author.

. . . When at 8 o'clock the two hundred horses of a field battery came to occupy their ill-gotten shelters, it was impossible, even with the help of glasses, to find the smallest trace of manure—no more, for all that, than any vestiges of stables. . . . .

Trench artillery, being compelled to fire at close range, must expect to perform duties which seem, at first, absolutely foreign to the functions of the arm. For instance, such batteries may have to advance, and therefore to carry guns and ammunition to places where shelters are not yet half built, and even to trenches just wrested from the enemy.

. . . An order just came, that takes us away suddenly from the much-needed rest which we had been enjoying for 24 hours after a month's continual labor.

While my two fellow officers are making a reconnaissance, I get everything ready. I patch up the pieces and gather the torpedoes.

When they come back all is in readiness. We consult hurriedly together. Our orders are: to go to position, with 10 mortars and 700 torpedoes, 200 mètres from the last German trench, and to be able to open fire to-morrow at dawn.

This means eight days' work to be done within eight hours with an exhausted personnel. And it is a foolhardy undertaking, for the only access to the place is by the highway, enfiladed, for four kilomètres, by hostile artillery.

But they are relying upon us: consequently we are going to try an almost desperate method: instead of carrying ammunition and guns on men's backs, as it is usually done during the last and most dangerous part of the advance, we shall go all the way with our 16 transport wagons. Some of these may be blown up, but the others will reach the goal.

I shall lead the column, while the captain and the other lieutenant will go ahead and prepare the position.

Les grades sur moi! (noncoms., assemble around me).[1] Sergeants and corporals come to me; the orders are plain: each one to take care of his own wagon; every one for himself; one must reach the position at any cost . .

The night is as black as ink. A fine, icy rain is beating us. At times white flashes disclose the distant crests. Back of me, separated by intervals of 20 mètres, the wagons are rolling, jerked by the shell holes with which the road is riddled. The torpedo wings, by striking against one another, are making a dull rattling noise which must be heard from far. .

The *chariots de parc* (familiarly called *prolonges*), which are used by trench mortar battery, are old-fashioned, rather crude affairs, springless and very noisy, even when they are empty.[2]

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[1] *Grade* generally refers to noncommissioned officers only, while *cadres*—literally, frame—(always used in the plural) include often officers.

[2] That colloquial word "prolonge" should not be confounded with the other artillery term which means "gun ropes."

. . . Reports of guns and *marmites'* bursts are now heard.[1] I see two or three shells percussing on the white line which indicates the road we had just been following; others whistle alongside of us and burst right and left in the fields . . . .

The column goes through a hamlet, or rather the ruins of it. Many men, wounded during the day, are there, in the rain and under fire, still awaiting the ambulances. Soon the battery enters the zone recently taken from the enemy. The road is becoming still worse and the rattling of the wagons dangerously loud.

. . . Truly, only we *crapouillots* can start on such a venture. I notice shadows in front of me: "Who goes there?" Vehicles are standing in the middle of the road. They are three *caissons de ravitaillement:*[2] a non-com. is nearby and seems to be in a quandary. I called to him roughly: "What in . . are you doing here?" His voice sounds almost toneless. He stammers out that he cannot go on, because there are to many shell holes on the highway.

I shrug my shoulders and hustle his horse about. "I guess ye, p'rhaps are a-thinkin' ye'll find the *Boul' Mich*[3] here!" says with contempt the leader's driver of my first wagon. . . .

The column goes on, past an infantry post, where it is cheered in the dark by some men who are eating near rolling kitchens. Finally it is ordered to stop at a place where a tree, knocked down by a shell, bars the road. A talus rises to the right; to the left is a *boyau.*[3] Hostile projectiles are falling every five or six minutes. The author states that they strike the road in the intervals between the wagons. As they do not do any damage, we must infer that either they never bursted, or else the cone of dispersion was extremely narrow. It is to be regretted that Lieutenant Arnould has not deemed it necessary to give here, as well as in many other pages of his book, any explanation concerning the apparent harmlessness of German shells on that front.

"Dismount!" How enervating this halt is! I go from one wagon to the other, chatting here and there. No casualties; the morale is good. Some of the men are joking. . . . Suddenly, with a sonorous "Good morning, boys!" the first lieutenant, smiling, appears on the talus. "Everything is all right," he says. "The work is progressing. The infantry is helping us. But the column must go over that tree or by the side of it, at once, for the captain is waiting for us." . . .

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[1] *Marmite*, in army slang, means a large German or Austrian shell.

[2] Not belonging, of course, to the trench mortar battery.

[3] Slangy abbreviation for *Boulevard Saint Michel*, the main thoroughfare of the Latin Quarter in Paris.

It is then decided not to try to remove the fallen tree, but to cut out a passage, on the left of the road, across the trench and the *boyau.* The cannoneers, who had gone ahead to prepare the mortar's sites, are called back and, with picks and shovels, they soon make an opening wide enough for the wagons.

"Forward!" I place myself at the turning-point to show the way to the drivers, and as they come up to me I catch the leaders by the bridle to help them. It would never do for a wagon to upset or to get stuck there, for that would bottle us up.

The first wagon passes through without any trouble. Things will be all right in so far as this is concerned; but what a jolting! And what rattling and banging! If the Boches do not hear it, they are stone deaf!

The wagons are following one another. . . . .

Well, here it comes! Here is the *arrosage*![2] Fortunately the Boches are shelling the part of the road stretching between them and the fallen tree; that is to say ,the one we decided to avoid. If only they do not increase their range! . . .

The wagons are trotting. A *marmite* bursts close to one of them, which is driven with reins. The driver, on his box, is surrounded with splinters. Unhurt, he goes on into the darkness, remarking: "What do you know about that?."

The enemy realizes evidently that something is taking place near by. Shells become more numerous. A little gun especially is very annoying, although projectiles are very small, and not powerful.

. . . We are now in an open field, gliding along German trenches recently abandoned. The men are getting more nervous. . . .

At last, here is the foot of the last crest. The Boches are only 300 mètres distant. With all their might the men unload the wagons. No *marmites* any more; but the little gun is more active than ever. . . .

Our escape is truly miraculous, for not a soldier is hit. My horse alone has been struck by tiny fragments.

Ouf! the last wagon is emptied; it goes away at a trot. . . .

Our captain, meanwhile, had been doing wonders. So did the infantrymen who have lent a hand to our cannoneers. The new trenches are almost ready, even though they are not very deep.

At six o'clock, as scheduled, our ten mortars are in position with their seven hundred torpedoes. . . .

A trench mortar battery may consist of, say, ten or twelve guns; but very often, in its sector—which is that of the infantry division—it has to be fractioned according to the requirements of the moment, each one of the three officers taking charge of a certain number of mortars and adjusting his fire

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[1] Narrow passage or gallery for communication in the trenches.

[2] Literally "sprinkling." *Arroser* is to search an area.

separately, and establishing his own observation station. As a rule, this station is very near the pieces; but it is always connected with the latter by the telephone—although the different fractions are not necessarily connected with the battery commander. At any rate, communications, either by telephone or messenger, are not easy in that branch of artillery on the firing line. It happens that a chief of platoon is so completely cut off from his mortars that he looses all control upon them. One must notice, in that connection, that the interruption of communication is not always due to hostile fire: the mortars are so far ahead and, at times, so near the enemy's line that the battery may be much endangered by "shots" from the friendly heavier guns—and even by shots fired by other fractions of the same trench mortar battery. Moreover, the range is so short that observers are liable to be handicapped by the bursts of their own torpedoes, even when the latter are falling upon the objective. The extracts that follow are dealing with this subject.

"Here is the firing map." The lieutenant spreads out on a table a map of German trenches upon which marks of different colors show, according to calibres, the respective objectives

"You see, that will be fine, right there; so much the more so because our *crapouillots* are going to help on that salient and on this one, too. Humph! . . . With his nail he pressed on the salient, mauve colored.

"Unwholesome, this part of the landscape!" said he. "Some heavy ones, 155 short—and the two trenches are not even 25 mètres apart! Certainly some projectiles from these guns, just back of us, will fall short, right on our mortars. To adjust our fire in the first line of trenches, we shall have to be extrordinarily prompt!"

"Well," said I, "the only way is to divide the work betweeen us two[1] Each will take two pieces and act independently. The adjustment, therefore, will be done in a few minutes. We should be very unlucky indeed if an ill-adjusted shot from our heavy batteries were to hit us just during that time." . . .

. . . In the functions of a *crapouillot* there is a period which always seems very impressive to me. It is the few moments immediately preceding the opening of fire. The pieces have been carefully given the needed elevation; their platforms have been reinforced. The telephone operator, crouching close to the talus, verifies his apparatus, while near him under the trajectory of my own projectiles, I am seeking a convenient place from which I can see the objective. Nearly every one in the trench is hidden in the dugouts. A few watchers alone have remained at their posts. Watch in hand, I look at the little hand which, very slowly, goes toward the specified time. . . .

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[1] The captain was then on a leave of absence.

"Attention! Fire!" Two snapping reports indicate my *Departs.*[1] The eye can follow both torpedoes, very high in the sky. They seem to fall back upon me. . . . The torpedoes strike the ground together, so near us that the operator and myself have to get under cover. One of them appears to be in the German trench; the other one is a trifle short. One must hurry, for the smoke begins to hide the objective:

"Hello! First piece: all right.

"Second: 45 degrees, good in direction. Fire as soon as ready.

"Hurry up!" . . .

The lieutenant faces the objective, while the operator looks toward the mortars, ready to shout a warning to the officer if a torpedo seems short during its flight. In the next salvo the first shot is on the target; the second, not seen. But just then the dreaded "short" of the friendly 155 falls about 5 metres from the observation station.

. . . The Operator shouts to me laughingly: "The next shot will be for us, lieutenant!"

Now the Boches, too, are shelling us.

"Gracious! Let us hurry with the adjustment. Why don't these blamed torpedoes come? Hello, hello! Hurry up! Fire!"

But the wire has been cut; suddenly a deafening report is heard: the lieutenant and his telephone operator, both wounded, are almost buried in the crumbling talus. At that moment the torpedoes from his own mortars begin to fall around him.

. . . Obviously, my mortars are out of adjustment, and as I am unable to make any correction in the firing, they are going to destroy our own trench. We must warn them at any price. . . . .

Bleeding and dizzy, the officer, compelled to leave his wounded operator under fire, tries to find his way to the mortars. But, although he is separated from them only by a few metres as the crow flies, such is the damage done during the last fifteen or twenty mintues to the trenches and *boyaux* that he loses his way. After much wandering, he is picked up by some infantrymen, as he is just fainting from exhaustion and pain. He masters, however, enough strength to mutter:

. . . An agent of communication, quick! Go to the torpedoes; tell the men to stop; that I am wounded. . . . . To make sure, send another, at the same time, to the sector's commanding officer: he knows where the *crapouillots* are; he will notify them.

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[1] In the up-to-date trench artillery vernacular of the French *depart* (start) means a gun's discharge.

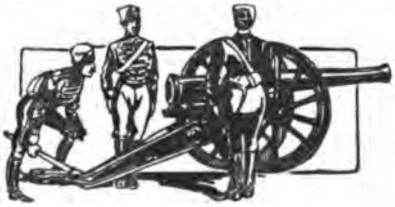
Then he falls back unconscious. Fortunately, in the meantime, the first lieutenant of the battery had seen, from his position, the erratic fire of his comrade's mortars. Running, in spite of the shells, on the top of the talus to save time, he had reached the two harmful mortars, corrected the firing, and achieved the work.

It is hardly necessary to add that since this book was written trench mortars have been perfected in many ways. It seems that, on the Allies' side, the greatest progress has been accomplished, in that line, by the Belgian Artillery. It is not known, at the time of this writing, whether the name of the inventor of the Belgian mortar may be made public: it was not allowed last August.

The mortar in question is very small; it cannot be seen at 50 metres. Four men are sufficient to carry and to serve it. When the fire is adjusted, it generally remains so. As regards range, the greatest variation between the bursts of successive shots is hardly 3 metres. Therefore, as soon as one has got the range and the objective has been hit by a torpedo, one may proceed with the firing without any correction for elevation: any projectile will be effective. This steadiness, which does not interfere with the rapidity of adjustment, is obtained through an apparatus whose description cannot be given here, for obvious reasons.

This mortar fires two kinds of projectiles, weighing respectively 19 and 36 kilogrames (about 38 and 72 pounds). At the extreme range of one kilometre the lateral deviation does not exceed 3 metres. It is easily and cheaply manufactured in any plant out of 3-inch steel bars

—*Field Artillery Journal.*



Co-operation Between Infantry and Artillery in the British Army

By Major D. M. McRae, Infantry

LACK OF CO-OPERATION IN THE EARLY STAGES OF THE WAR

For quite a time after the war began there was little or no co-operation between the infantry and the artillery and what was worse there was a bad form of antagonism. This was due to a number of causes. In the first place neither branch knew practically anything of the other and had no conception of the troubles and limitations that controlled the actions of the other. Both branches were prone to too much secrecy and disastrous operations were carried out without the necessary consultations taking place. It used to be nearly a physical impossibility for an infantry officer to learn anything about the batteries covering him or to visit the artillery O.P.'s (observation points) on his front. Another item in this awful misunderstanding was the shortage of shells. The infantry blamed the artillery and the artillery were too touchy to take the trouble to explain.

GRADUAL IMPROVEMENT

When matters were at their worst some genius must have taken charge, for an improvement started due to no one that could be traced. This improvement was very gradual at first and sort of half hearted, but was soon going along full swing by leaps and bounds. Personal acquanitances between the two arms became the watch word. There were plentiful invitations from the infantry messes to the artillery messes covering them and vice-versa. As a result of these dinners, bridge parties, etc., and of the information gained here of each others difficulties, each branch began to realize that the other was not entirely composed of a collection of grouchy rotters, and that a large part of the blame could be laid on each side.

One of the first things noticeable was that where an artillery man and infantry man met there were friendly words of greeting and mutual congratulations over a good piece of work done, instead of the old curses and black looks. But above all each branch began to ask the other questions and would get pleasant answers.

This good work was greatly helped along by a series of good addresses given by artillery officers to the infantry and vice-versa. From this time on it was a common sight to see infantry officers at the batteries and O. P.'s, (observation points) and they were always certain of a warm welcome by personal friends. The author has the privilege of counting many of his best personal friends amongst the artillery that has covered the fronts he has been on, and recalls with great pleasure the times he has been allowed to fire different calibre guns into Fritz back country. He is also certain that numerous artillery officers have enjoyed their trips to sniper's posts for the chance of a little hunting.

A big factor in the maintainance of the now almost perfect co-operation is the presence of artillery Liaison officers in the front line. There is one such with each British battalion and he don't just sit around the headquarters dugout. He is supposed to be the shadow of the battalion intelligence officer and follows him all over the frontage. These two work hand in glove for the discomfort of the enemy and the increased safety of our troops. They compare maps and at once correct any disagreement. The names and locations are checked of all sections of front line trench, bays, posts, craters, gaps, etc., and any changes at once given to the artillery. Serious mistakes will be made unless these maps are identical and it will be the infantry's fault. When the battalion observers locate an enemy battery, trench mortar, or machine gun, the information is given to the artillery at once and they pass back the information as to the result of their fire. Each branch has a pride in its share of the good work. The following incident that came under the author's notice will illustrate this close harmony in which the two branches work and which would have been impossible a year and a half ago.

Opposite the city of Lens there is a huge pile of slag from one of the coal mines, called the Double Crassier. It is a long mound about two hundred feet high and twelve hundred yards long with a very narrow top of about eight yards and extremely steep sides. One end of this Crassier is at our front line and from there it runs across No Mans Land to quite a distance behind the enemy front line. We have dug a sap running up the end in front of us and a narrow trench along the top so that the post at the end is about on a line with the German front line, way down below in No Mans Land. The Germans have a sap on top also that runs up to within ten yards of ours, but they were so close that a sort of "status quo" was established. From this wonderful watch tower all the surrounding country could be seen, on the right clear down to Vimy Ridge and on the left to Loos.

There had just been a number of successful raids against the Germans and they were very jumpy and kept numerous machine guns swinging over the whole country-side every night. These guns while they did little damage were an awful nuisance and to some extent interfered with the nightly working parties who were in the open. Besides this there were a number of large trench mortars (Minnenwerfers) located very near the foot of the Crassier which had a habit of lobbing their huge bombs over top of the Crassier into the trenches of the battalion on the north. Then while up on the Crassier one night an officer observed the relief of a German listening post crawling out in the snow directly below him, and took its position and the times of relief.

Then a little surprise party was organized. Some artillery friends and one from the brigade machine guns were taken up on the Crassier and they immediately entered into the spirit of the game. (Right here it ought to be stated that when they have plenty of ammunition as they always have now, the artillery are almost childish in the joy they take in letting off their guns at almost any old target the infantry finds for them.)

When the visiting officers had grasped the idea, a systematic effort was made to locate all the enemy emplacements and have these accurately registered in daylight, from the Crassier. This registration was done in such a way as to lead the enemy to believe it was just desultory shelling. The Brigade machine guns were then accurately registered on the path taken by the relief of the listening post. This was done by watching the bullets kick up the snow. When this work was done a "tug wire" was rigged up from a good observation post on the Crassier along the top and down the back to a place where a man with a signal lamp was invisable to the enemy but could be seen from an artillery observation tower in a town, well to the rear. In this tower was an artillery officer with a set of push buttons that connected with the different batteries.

When all was set and it was dark an infantry officer crawled out to the observation post tugged a few times on the wire in his hand to see if his signal man was on the job and then waited for developments.

The first thing to happen was for one of the trench mortars to go off. The flash had hardly died away before one tug was sent back, one flash given on the lamp one button pushed in the tower, and four, four and a half inch shells landed on the T. M., (Trench mortar) emplacements. This must have surprised the enemy but didn't quite put him out of action for he fired again and the same process was repeated. He was never heard of again.

Practically the same thing happened to the other T. Ms. and then the German machine guns started their nightly song. They received the same treatment as the T. Ms. A machine gun can't very well compete with a salvo of well placed three-inch shells. There was no more machine gun fire for days and then they would just fire short tentative bursts to sort of see what would happen.

The serious part of the work now over, there was a lot of amusement caused by playing with the relief for the listening posts. Every time they would try to crawl out a well directed burst of machine gun fire would land on them and they would slide into a shell hole. If one man lifted his head the gun would open. It must have caused a lot of surprise and wonder as to how a machine gun about twelve hundred yards away could see to fire at the slightest movement of one or two men on a dark night. It probably never entered their heads that a Canadian Infantry officer was lying straight above and could see every move against the snow. This very interesting game continued for some time until a man with a rifle couldn't resist the temptation any longer and shot one of the Huns. This must have put them on to the game at once and broke up the "status quo." Shells began to remove the top of the Crassier so the game was called off for that evening.

This is given just to show how all the branches can work together and cause a great deal of local damage. When this kind of thing is extended over the entire front it amounts to something. This was done under very special conditions but other conditions and other opportunities exist at other places and must be utilized whenever possible.

Information that the infantry should give the artillery:—

(a) As mentioned before they check up maps and at once let the artillery know of any changes in posts, etc.

(b) Distinctive sign boards should be put up against the parados of different sections of the front line as it is very difficult to tell our trench from the enemy's when looking from an O. P.

(c) Immediately send in any bearings of T. Ms., M. Gs, (Machine Guns) or batteries obtained giving map locations of point the bearing was taken from and time taken. You may only get one bearing, but others with other bearings may send theirs in and give enough data to locate the target.

(d) In calling for retalliation the enemy's rate of fire and calibre of his shells should be sent back so our artillery can know what size and rate to use.

The principle of retaliation calls for a faster rate of fire with larger shells than the enemy is using. Often a big artillery fight will start from a mere trifle; maybe some one will heave over a trench mortar bomb, the other side sends back two which compliment is returned by four. Next some artillery is called in beginning with three-inch; they work gradually up the scale until the fifteen-inch may even get in the show. Then every thing goes full swing, the infantry of both sides being the target until one side calls quits and gets its artillery fire to die away.

It is usually the German who gives way, both because his morale is not as good and because he is weaker in artillery power than the Allies. After the German guns let up we usually pound for a little while longer and then quit ourselves. After a few experiences of this kind the Hun Infantry will be loath to call for his artillery fire and will take a certain amount of punishment without coming back strong. We find out this limit to his patience and work right up to it.

(f) Any movement of the enemy that any infantry officer may detect or suspect, especially working parties, ration parties, or above all, reliefs, should be gotten to the artillery, through the Liaison officer, just as quickly as possible. This
ust the chance the artillery is looking for and at night the
ntry are the ones who discover these things.

(g) The following is the kind of thing that an infantry lieutenant may have to do any night, and was worked very successfully to the author's knowledge.

A German wiring party was seen and the men in the front line not allowed to fire. If they had opened up, the chances are that no Germans would have been hit, as it was night, and the fire would have driven them into their trenches with no damage done. The infantry officer decided on a zero hour and put three Lewis guns in position with orders not to fire until the time specified. He then ran down to the trench mortar headquarters dugout and arranged for them to fire at the same time. Next he got hold of the artillery Liaison officer and arranged for the artillery to open at the same time.

At zero every thing let loose, in a short burst, all together, the idea being to get over all the explosives possible in the short time it would take the party to get from their work into their trench. From the cries the fire was highly successful.

The following are some of the things that an infantry officer must take the trouble to find out for himself:

(a) What batteries are covering his front.

(b) Where the Liaison and F. O. Os. (Forward Observation Officer) dugouts are.

(c) S. O. S. signal.

(d) Where the T. M. dugouts are.

(e) Barrage lines (S. O. S.)

(f) Forward O. Ps. (Observation Posts).

(g) Quickest way of getting in touch with his artillery.

The artillery covering him is just as much a part of his defense as his men and Lewis guns and he should know how and when to use it just as well as he does the other weapons at his disposal.

The following are some of the things the artillery must be certain to tell the infantry:

(a) When their range will be dangerous to the front line or outposts.

(b) When a shot will be likely to bring heavy retaliation and what steps have been taken for a counter-retaliation.

(c) Any changes in disposition.

(d) Any changes in Barrage lines.

S. O. S., OR RETALIATION PROGRAM

Short Rounds.

(A) These were the cause of most of the grievance of the Infantry against the Artillery and this grievance was mainly due to the fact that the Infantry didn't know the reasons for these shorts. They felt certain it was due to the gunners' carelessness. They now realize that this is so rare as to be negligible. The main causes for short rounds are:

1. Defective ammunition (charges or fuses).
2. Error of gun (50 per cent and 100 per cent zone error).
3. Heated or worn gun.
4. Prematures.
5. It may not be the guns covering your front.

(*B*) *Immediate steps to be taken.*

1. Do not lose your head.
2. Withdraw men if fault continues.
3. Advise Artillery. Do not start the conversation by a flow of profanity. It will take just that much longer time to reach an understanding during which time you and your men are apt to be hurt.
4. Give artillery as accurately as possible:

a. Map location of bursts.
b. Type of shell.
c. Height of bursts.
d. Angle of fire.
e. Number of rounds and time.

If the above procedure is followed the matter will be quickly corrected and you will invariably find out it wasn't the gunner's fault.

CO-OPERATION DURING ADVANCES

It is during the advance that the Infantry reaps the benefit of their efforts at establishing cordial relations with their Artillery. Without the most perfect co-operation the best trained Infantry is lost.

Before the attack the Infantry can be of immense assistance to the Artillery in locating enemy batteries, T. Ms., Machine Guns, O. Ps., etc., and in reporting on the results of wire cutting. Since the infantryman's life depends on the excellence of the Artillery, it is up to him to use every means, day and night, of getting all the information possible to the Artillery. The trained scouts and observers do a good portion of this work and just before an offensive the battalion intelligence officer is one of the busiest and most important men on the front. He is a sort of general information bureau for his frontage and must be fully prepared to answer the most minute questions as to his own and the enemy lines.

He will be called upon to give lectures to the battalion on the nature of the ground behind the enemy front line, as determined from observation, maps, and air photographs. He will have to take all kinds of staff officers to his O. Ps. and explain everything in detail. He will have to run the patrols all night and the O. Ps. all day. There is practically no sleep or rest for this officer at this time. It is on his shoulders, that most of the responsibility rests for the close touch kept with the Artillery.

When the attack has once gotten to its objective, it is of vital importance that the artillery be notified at once as to just where our and the German lines are. It is no use calling for S. O. S. fire, when the counter-attack comes, unless the artillery knows just where you are. They can not put down a barrage without knowing where to put it. The best way to give them this information is by means of a sketch showing your position and that of the enemy as far as possible. These little sketches can be all drawn except the actual line before the attack starts and take only a minute to complete. Information of when and where your battle patrols are being sent out must be given to the artillery at the same time; otherwise they may be cut up badly by our own fire.

A method of locating our lines that is in common use now is by the use of air maps. A contact machine is assigned to a certain sized unit usually about one per battalion or brigade and it flies over low at prescribed times, say once an hour. At these times it sounds a succession of "Gs" on its Klaxon hour and the infantry then light-flares all along their front. The airman puts in the line on his map from these flares and after taking any visual messages sent, flies back and drops his information at a report center. From here it very quickly gets to the artillery.

The subject of the best means of communication in assault has been covered so fully by so many experts that it will not be touched on here except to say that it is one of the most important featurs of the assault and if not properly arranged for beforehand, will be very likely the cause of losing a lot, if not all of the ground taken, when the counter-attack is launched. Only too often the success of the entire operation depends on the quality of the information sent back. If an infantry officer hasn't a clear conception of this work for his own sake and the sake of his men, he should at once make every effort to get some of the War Department publications on the subject. The information he will get from an hours' reading may very well mean the difference between success and failure in a few month's time.

In conclusion of this subject of co-operation it is again stated that it is the infantry who receive the greatest benefits and whose very lives hang on it and therefore they must not sit around and wait for the artillery to open negotiations, but must get up and start things. They should drop this banter at messes, that is so noticeable at present. While done only in fun it tends to draw a line between the artillery officers and the infantry officers.

In a mixed mess you will notice that one branch sits on one side of the table and the other branch on the other, a kind of mobilization for the battle of witty remarks that takes place at every meal. This is wrong and while apparently harmless in peace conditions may have very serious results in battle. Get together. Both branches are members of one big service, each by his own work, aiming and helping toward one big result, the destruction of Germany.

—*Infantry Journal.*

Camp Sanitation in Trench Warfare

By A Military Observer

In the first line trenches each battalion section has one or more regimental aid posts i/c of R. M. O.

1. *Infectious Diseases.*—All cases showing fever are immediately evacuated to rest station, where they can be observed and isolated, and from there sent to casualty clearing stations, from where they are evacuated to the base. Contacts to mumps and measles, trench fever, and hemorrhagic jaundice are not interfered with. Those from diphtheria and cerebrospinal meningitis and scarlet fever are sent back in quarantine. Those from scarlet fever are kept for ten days, those from diphtheria and cerebrospinal meningitis until bacteriologically clear on two consecutive negatives at least twenty-four hours apart.

The underlying principle is to get all infectious cases out at the earliest possible moment from the well.

2. *Water Supply.*—(*a*) In petrol tins carried up with rations from 200-gallon twin reservoirs, at nearest point possible to lines. Twin to facilitate alternate chlorination. (*b*) From farm wells in neighborhood, always chlorinated. (*c*) From wells approximately 500 yards back in bays of communication trenches. (*d*) Water bottles brought in filled from chlorinated designated sources as men go into trenches. (*e*) In strong points a store of chlorinated water is always kept in rum jars. In tin cans objectionable tastes develop. (*f*) In one place water was carried from highest point up stream to a 3 by 4 by 2 feet deep box filled with clean sand—run into a twin reservoir where it was chlorinated. (*g*) In another area pipes were led into trenches from supplies in the back area.

3. *Food Supply.*—(*a*) Each man is supplied with three days "iron rations, " to be used in emergency only. (*b*) Otherwise carried up every night. The fresh meat is cooked in the reserve area and brought up in labelled sandbags to be warmed

up for each platoon. Coke is supplied for warming up in trenches, also to make tea. (*c*) In the winter hot soup or cocoa or tea is brought up in 2-gallon insulated petrol-tins for use after 1 a.m.; 10 ounces for each man.

4. *Sullage Water* and ablution water collected in tins to be carried back and emptied on soil or in holes where it will not be a nuisance.

5. *Refuse.*—Is collected in sandbags hung up at intervals in trenches, to be carried back and burried in the night—usually within 200 feet of the trenches. In some cases it has been carried back by the ration parties to be burned in the "rest area."

6. *Excreta.*—Collected in petrol drums flyproofed with 1 per cent cresol solution; the faeces pails in addition are provided with improvised automatically falling covers; "chloride of lime" is freely scattered around about. At night the faeces and urine are burried inside of 200 feet of the trenches generally.

7. *Bodies.*—Generally are not buried locally but brought back to cemeteries usually from 1000 yards on from the trenches. They are covered with 3 feet of earth at least when possible.

8. *Vermin.*—The men are supplied with a powder to dust into clothes and an ointment to rub into seams of underclothes and breeches; the active principle there is crude petroleum.

9. *Rats.*—These are a great nuisance and numerous traps, dogs, cats, and ferrets are used for their destruction and the men kill many of them. We have not used poisons or virus; we are afraid of the virus (too closely related to enteric group), and the men are too closely associated with the rats. In case plague should come about we would have to; perhaps more rigid destruction of rats would protect us against trench fever, so called.

10. *Trench Feet.*—(*a*) Drain trenches as much as possible. (*b*) Use "waders," kept in trench stores, thigh high. Puttees are removed on coming into trenches always. Each man brings with him 2 pairs dry socks; each night 2 additional pairs are brought up with rations in watertight bags. Men wash and dry feet at least once every 24 hours, using afterward a talcum-camphor powder; care is taken to have them move about. Each platoon officer is responsible for the carrying out of these precautions.

11. *Inspection* is done each day by the regimental medical officer. The responsibility of keeping the trenches clean and sanitary rests on the commanding officer and his staff. The medical officer has advisory capacity only.

12. *Personnel.*—Each company supplies a sanitary squad and is aided by a sanitary fatigue when necessary.

Reserve Area.—Usually about 1000 yards behind front line. (1) Vermin, as in trenches. (2) Food: Can usually be cooked without hindrance. (3) Water Supply: Water carts brought up here, chlorinated always from designated sources. Local wells not used at all if can be avoided. (4) Milk: No lolocal milk is used; either condensed or milk powder used. (5) Excreta: Fly-proofed always; tin biscuit boxes enclosed in wooden boxes with automatically falling covers; cresol solution in cans, burried. In dry alluvial soils, pits are dug and closed seats placed over them, the area fenced off. Kept dark, these pits do very well 1½ feet wide at top, 2 feet wide at bottom, 4 by 5 feet deep, but thoroughly covered. When unit goes out these are thoroughly filled in and marked. (6) Refuse: Still has to be burried. (7) Sullage water: Radiating shallow trenches filled with old tin cans and covered with earth are used. A tin box filled with grass or straw with chloride of lime scattered through it deals with this very well. The trenches are 1 foot wide, 2 feet deep and long, according to the absorbing quality of the soil.

Cemeteries.—Usually in this area very well kept.

Rest Area.—Usually 4 or 5 miles back from the front lines. Huts, billets or tents. There are three field ambulances per division. One of these is in rest generally, one is conducting a "rest camp" for the care of non-infectious temporarily sick and has one section for the reception, sorting and distribution to casualty clearing stations of infectious cases. Scabies cases are usually treated at the rest camp. The other field ambulance has charge of the advance dressing stations and the main dressing station of the division.

Convalescent Camp.—In charge of a combatant officer; looks after the chronic sick room visitant and light duty men. From this, fatigues are supplied for all kinds of odd jobs.

1. *Chlorination and Distribution of Water. In the Camps.* Each 500 men has a water cart assigned them with a constant water detail in charge, who always carries his own supply of calcium hypochloride in quarter-pound tins with him on his

cart and always does his own chlorinating. There is a standard measure in each tin. A tin is used for four days only, then discarded. Tins with wet or colored contents are immediately replaced. The supply of these tins is got with the rations of the unit. It is the "water detail's" duty to keep his cart in good repair and clean. There is a driver to look after the horses. Water is to be taken from approved and assigned supplies only, and always to be chlorinated—no chances are taken. By frequent tests, using the iodine tester, the number of measures to be used to the standard cart (100 gallons) with each water is prominently indicated on signboards at each source, where a special detail usually from the Sanitary Section is placed to see that the "water detail" men do the chlorinating. A record of each cart, the hour of taking, the unit, whether supplies are with them, whether the water tank is clean and whether the "water detail" accompanies the cart. It is the "water detail" man who puts the chlorine into the cart. In many of the areas there are well-organized piped, hydranted or water-tanked systems. The standard canton flannel filters and alum chlorifiers are practically never used. They soon deteriorate and get out of repair and generally on the rough roads tear the water-cart tanks all to pieces˙ Some of the waters require one measure, some as high as four.

2. *Reduction of Fly and Insect Pests.*—(*a*) Mosquitoes. All ponds and stagnant waters, whether used for washing water or horse-drinking water, are in the mosquito season oiled once a week, using about 4 ounces of coal oil for each 200 square feet of surface. (*b*) Flies. All refuse is burned daily. Horse manure also and human faeces either burned or buried. Food stores are screened as much as possible. Some have tried the biothermic method of disposing of horse manure. It is not a success in camps; no one will take the necessary trouble required. Strong solutions of borax or cresol frequently sprinkled on manure have been tried but have not been brillaintly successful. With all refuse and horse manure burned the flies nearly disappear.

3. *Campaign against Rats.*—No serious campaign against rats has been undertaken. They are a great nuisance, but they are fine scavengers. The men kill them on every occasion. The cats and dogs and ferrets of the trenches get rid of a good many of them. Traps are used, but are not very successful. Poison has been proposed, but we have enough self-inflicted wounds already, and there is a general objection therefore to use poison.

Rat-infecting bacteria have been advised, but these organisms are so closely related to the colon group of organisms that we do not use them; of course, if plague were to come on the scene, steps would have to be taken to meet the rat pest, but so far nothing serious has been done.

4. *Disposal of Kitchen and Ablution Water.*—This is most satisfactorily done by using the can—filled radiating trenches as with the disposal of urine, but, in addition, to place alternate layers of straw or grass and a liberal allowance of calcium hypochloride in a straining tin at the hub of the trenches. When soiled, the straw or grass is burned in the incinerator.

Destruction of Body Vermin.—(*a*) Bed bugs are almost unknown among the troops. (*b*) Head lice cases are rarely encountered. As a preventive the hair is kept clipped; as a remedy vaseline or coal oil is used, being careful to prevent blistering. (*c*) Body louse infection is frequent. For their destruction: (1) A powder for dusting into the clothes and an ointment for application to the seams of underclothes and trousers is supplied. The active principle of both these preparations is crude petroleum. It is fairly effective, but there is some difficulty in getting the men to intelligently and regularly use it. (2) Baths, usually shower baths, are given as frequently as possible, usually every three weeks, after which the men are given a clean set of underclothes and shirt, but since from 25 to 40 per cent of the lice on each individual are present in the crotch seams of the trousers, respreading soon takes place. To meet this contingency in the smaller bath places, whilst the men are taking their baths, the trouser seams are ironed with hot flatirons. This helps out very much. (3) One large central bath is usually provided for each division, where from 1000 to 1500 men can be bathed each day. Some of these are provided with a Fodden disinfector—two large pressure steam sterilizers on a motor lorry, the steam being supplied by the boiler of the lorry. A temperature of 100° to 110° C. is attained in these but when men's clothing has to be put through them at a rate of 100 to 150 sets per hour, it is too slow and only the most seriously infested sets are done. The Belgians at their two main bath houses put the men's clothes, each in his own bag, through the same process, but use a much larger disinfector supplied from a large stationary steam boiler with convenient mechanical devices for quick handling, and get the best of results. For our troops who are continuously on the move, the Belgian apparatus is too cumbersome and the boilers too heavy to be portable. (4) To rid men completely of their lice it is necessary that all their clothing be done at one time, including even their great coat and, where possible, their individual blankets, and this should all be done when they are taking their bath, in a matter of from 25 to 30 minutes. Many of the units have put up disinfectors after the following plan, and with almost complete success, even under the difficulties of active service. Two contiguous rooms, double walled, sawdust filled, 6 feet wide, 10 feet long and 6½ feet high, with a door at one end and a 1-foot wide, 3-foot long window at the other end, with hooks from the ceiling on which to hang a numbered wooden holder for the clothes of each man. Around the walls are placed five rows of radiating 2-inch steam pipes, kept continuously hot by circulating steam supplied usually by a standard threshing machine boiler. In the center of the floor, with a protecting shield over it, is placed a free steam outlet, all regulated from the outside. The clothes, turned inside out, are hung in this chamber as the men go into the bath, free steam is admitted from the floor outlet, the door and window slightly open until the air is pretty well driven out (one minute), then are closed and the steam flow continued for five minutes, and shut off; the whole then allowed to stand for 10 minutes more, then the window and door are opened wide and the clothes taken out as soon as can be and shaken. They are dry and deloused and the eggs destroyed. The clothes are then handed to the men and can be immediately put on. Having two chambers, the work can go on alternately in one, then the other, and the whole process not take more than 25 minutes. The temperature attained is from 85° to 95° C., if the boiler is capable of keeping up in itself a pressure of 40 pounds per square inch through the process, and it usually can. (5) It is being seriously considered to fit up box cars in this way to be supplied with steam from a locomotive boiler for troops on the move. In Salonika this has been done successfully. (The men after their bath are issued clean underclothes, the old ones being left behind to be washed for future use.) (6) In some areas Clayton sulphur-gas disinfectors have been set up. With 5 per cent of gas in the chamber in which are hung the clothes, the lice and eggs are killed in one hour, but often not more than 3 per cent of the gas can be gotten into the room, 7 or 8 hours then being required to kill the eggs and the lice. It is rather slow for active service purposes. (7) In one casualty clearing station they sprinkled the clothes with gasoline, rolled them up tightly, then placed them in a small cellar room practically air tight, and left them so for 24 hours, when generally the lice and their eggs were dead. But this takes time and uses up very precious gasoline, and is not free from fire danger.

Disinfection of Clothing and Bedding.—(1) By steam in a Thresh disinfector, by the same process in the magnified Thresh or Fodden disinfector, or in the flowing steam room described as above. (2) By sulphur gas, either from liquified sulphurous acid containers or from that supplied by the Clayton disinfector. (3) A very effective method of dealing with body lice is by the hot air process. All that is needed is a thick wall tempered say 10 by 10 by 7 feet high. A dug-out would do, or any small room, provided it is insulated; clothing could be hung in this, and into the room a brazier placed and the door closed. The small window will allow for observing the effect of the heat on bits of paper hung here and there; if the paper browns, then air should be let in, but as a rule it does not. A temperature of 85° C. is easily got and with this temperature lice and their eggs are destroyed quite certainly in 15 minutes.

Construction of Bath Houses and Laundries.—Usually it is one bath house and one laundry on the same ground for each division, as near the center of the area as possible. For outlying concentrations additional small bath-houses are put up. Sometimes these conveniences are set up in buildings already existent (breweries), in other cases are new constructions. (*a*) Bath House. One put up last summer in ——— sailent combined the wants and the experiences of a couple of years. A small stream was dammed for a plentiful supply of water, the water was pumped by a small steam pump to an overhead tank which could serve for the laundry as well, also for fire protection. A water heater, on the plan of a Daisy water heater, was provided to supply hot water to a second tank to meet cold water, and from there be distributed to a set of rose-sprays piped overhead in a room floored with corrugated iron, duck-boards on top for the men to stand on; no cubicles provided. All the men bathe in one room, 40 at a time. A man from the platform regulated the tempered water and the supply to avoid wastage; the drainage went to a reception tank where it could be treated before entry into the stream with the laundry water further down. In the anteroom, provided with wall and center benches, the men undressed, their valuables were looked after by a non-commissioned officer, their soiled underclothes being collected into baskets to be washed and their jackets, trousers or breeches and great coats and blankets, if they have brought these last with them, were taken by attendants, a number being given to each man, and they were put through the steam disinfector whilst the men went on to the shower bath. After their bath, by another passage they went into a dressing room where they dried up and were given clean underclothes, shirt and socks, and then got each their disinfected jackets, trousers, etc. Reinfection with vermin was thus avoided—the whole process took from 25 to 30 minutes. (*b*) Laundries. In general the arrangements were as follows: Hot water in an overhead tank heated by exhaust steam or by a Daisy heater piped over the tubs; also cold water was piped there. Women hired locally washed the clothes in the ordinary tubs of the country, using wash-boards and soft soap, usually made up from bar soap (15 bars yellow soap, 30 pounds washing soda, 9 pails water, boiled together). The clothes had been previously disinfected either in a Fodden or in the chamber disinfector used for delousing. The floors were of corrugated iron leading to a central drain, thence to the reception tank. The women stood on duck-boards. The clothes were then wrung either by hand or put through a roller wringer (power driven) and hung outside to dry in suitable weather; otherwise they were dried in drying huts heated by stoves down the the center, the clothes hung closely on wires. The heated saturated air was periodically extracted by fans and, when properly handled, the clothes dried in 8 hours. After this the clothes were sorted and folded, not ironed, those needing mending being sent to the mending room. In winter 15,000 pairs of socks were washed and dried daily.

From the fact that the stream water had to be used again down below, the dirty water had to be purified. The following method gave staisfaction. Twin tanks of 6000 gallons capacity each were provided. When 3000 gallons of fresh laundry and bath water had reached this, 1 pound of hypochlorite of lime was added with thorough mixing to each 25 gallons of the stuff and then left standing for at least 6 hours, and whilst the twin tank was filling a thick, light scum of calcium soap enmeshing much fluff and other debris rose to the surface.

This was skimmed off, mixed with sawdust, and burned in an incinerator. The clean fluid left was run into another tank to be used over again and again when water was scarce, or after running up through a sand screen, it was discharged into the stream below. It was expensive, but it gave satisfaction; other methods and other chemicals might have done better, but they could not be procured. Hypochlorite of lime is supplied to us freely. The buildings for bath and laundry purposes are generally built of rough, cheap lumber and covered with tar paper and roofed in with corrugated iron.

Additional Rest Areas.—When a division has been in action several months in any one section and whose corps is not to be moved from there, it has been found useful to get it at a point further back out of gun-fire and out of the noise of the front where the men could do light training and rest.

The sanitation of any area is the duty of the O. C. in that area—his medical officer is his sanitary adviser. In addition to this we have a Sanitary Section composed of 27 men and a captain in charge—the business of this section is to co-ordinate the sanitation of the area and to inspect it. It is not their duty to do the fatigue work, they are there to instruct and to inspect—the O. C. of the Sanitary Section reports to the A.D.M.S. of the Division, and through him any recommendations reach the units concerned.

Our corps has, besides this, a sanitary adviser co-ordinating the work of the Sanitary Sections of the divisions of the corps. The army in which a corps is situated has a D.A.D.M.S. in sanitation, whose duty it is to supervise the sanitation of the corps and the divisions in the area. Daily reports of the infectious diseases arising in each corps area are sent to the D.M.S. of the army in which they are. In this way knowledge is had of incidence of infectious diseases in the whole area daily; the D.A.D.M.S. sanitation, goes then wherever there is indication of trouble. There is a mobile laboratory in each corps area to look after any analysis and bacteriological examinations when required in that area. Civil authorities reciprocate with the local military authorities in reporting infectious diseases amongst the civil population, and measures are taken accordingly in case of major infectious diseases. The patients are removed from the area and the homes from which they came put out of bounds for troops. The civil authorities look after the disinfection, etc. The military and civil

PROFESSIONAL NOTES

Commercial Value of Military Training

By Dr. Lewis Sanders

A stock argument of the opponents of universal military training is that it reduces a man to the state of a mere automaton, subservient to the will of another and that it further reduces his subsequent economic value.

Those advancing this argument have failed to grasp the object sought in military training and the results actually obtained. If a man were trained to the point stated, the result would be not a good soldier but a poor one, as he would be much like an overtrained athlete who has gone stale. The object of military training is to enable a large number of men to so co-ordinate their activities that under the conditions obtaining in warfare they may all work together without confusion to attain a common object. For the accomplishment of this purpose it is necessary for them to be subjected to restraints of their individual liberty of action in the same manner as are the members of any civilized community in order to enable that community to continue a successful existence. The restraints imposed upon the individual in military life are of the same general character as those imposed in civil life, but necessarily carried to a very much greater extent, owing to the much closer co-operation required. But just as the most successful civil community is that which restricts the freedom of the individual the least consistent with the attainment of the objects sought, so the best military training is that which imposes the minimum restriction on the development of the individual soldier consistent with the maintenance of control and discipline on the field of battle. Needless to say the military minimum is far in advance of any maximum ever dreamed of for civil life, but the basic principles governing are the same in each.

The layman's ideas of military discipline are largely obtained from the observation of drills in close order on the parade ground, where men are held at attention and act as a machine whose units are apparently deprived of all volition. The impression obtained is as far from correct as can well be. The primary object of this part of military work is to make the men automatic in the performance of those duties that are common to all (of them) upon the battlefield and to leave their minds free to grapple with the individual problems that will confront many of them in war. When a child is learning to walk it requires to concentrate its entire mind upon the subject and is unable to do anything else while walking; after walking has become subconscious and automatic the child is as able to devote its attention to other matters while walking as while stiting down. This is precisely the result sought by the disciplinary portion of military training—to make automatic those actions habitually required on every battlefield and thus enable the soldier not only to be used effectively by the commanding officers, but to enable him to use himself effectively.

An equally important part of military training is in developing the initiative and resourcefulness of the individual soldier. To quote the Drill Regulations for Field Artillery: "An additional object of instruction is to develop resourcefulness, initiative and self-reliance on the part of field artillerymen of all grades." That this has been accomplished has been amply demonstrated both in peace and war. If the contentions of the opponents of military training were correct, viz.: that it reduced the men to automatons subject to the will of their officers, control would disappear in the absence of the officers and the men would dissolve into a mob more helpless than one composed of civilians. The direct contrary is the case, for almost without exception when a body of men has lost its officers the sergeants and corporals take over the direction and go through with the task, and if they too fall, some private is sure to step in and take command. Individual soldiers, isolated on the field of battle, show the same resourceness and strong individuality. The same quality is likewise shown in time of peace. In any emergency soldiers, whether in a body under command of an officer or individually, will be found acting calmly and efficiently for the safety of others and in entire disregard of themselves. (So common are these occurrences among well-trained troops that it might safely be said that it is only necessary for an opportunity to present itself for it to be seized upon by the man nearest. No such high average of initiative is observable among civilians.)

Another object sought in training troops is to make them proof against panic and fear. Fear is a physical, not a mental sensation and operates by overpowering all mental processes. A man in a state of fear does not and cannot think. Sufficient drill and discipline make the control of the body purely subconscious and in this manner automatically suppress fear. (It is not only that the man has been so trained that he automatically obeys an order from an officer under stress of battle conditions but he is equally able to be commanding officer of his own body and issue his orders to it, and they are automatically obeyed.) The reason the civilian compares unfavorably with the soldier in cases of emergency is that he has not acquired any subconscious control of his body and therefore a large part of his mental resources are engaged in overcoming his physical fear, leaving a smaller surplus to attend to the situation in hand.

An excellent example of the results produced by this automatic control is the splendid record made for themselves by the girls at telephone switchboards in cases of serious disasters. Without exception every girl has stuck to her post, although many were in serious danger, until she had warned every possible person. Now there is nothing in the method of selecting these girls or in the traditions of the telephone service to make them any more courageous or self-sacrificing than the stenographers or other girls employed. What then is the explanation? The work of the telephone operator involves the repetition of the same operations repeated so many times daily that it becomes about as perfect a subconscious operation as
an be obtained. This has established a control for these girls that in times
f stress and emergency leaves them the free use of their minds, which
ey proceed to use in the most effective fashion. Miss Tessie McNamara,

the telephone operator at Kingsland when the munitions plant blew up, is a case in point. She pluckily stuck to her post until she had called everyone she could reach and warned them and then promptly fainted when she tried to leave. As long as she was at the switchboard she could work automatically and therefore her mind was clear to handle the situation. As soon as she left it she lost all her automatic control and was in the same position as any other girl in fighting her fear. If she had had a sufficient amount of some form of drill to make her going in and out of the plant automatic, she would not have fainted but would have taken herself out of the plant unaided as efficiently as she handled her switchboard. The telephone operator's training is narrow and she is lost as soon as separated from her switchboard. Military training has the advantage of covering so wide a field that there are very few conditions that arise in which a man does not preserve his automatic control. It is certain that the discipline that renders a man immune to fear will give him a great advantage over competitors in handling trying business situations. While these do not involve physical fear they do involve related sensations, such as worry and fear of assuming responsibility, and the habit that has overcome fear will overcome these also.

The question naturally arises as to whether this development of an automatic subconscious control can be carried to an extent that is injurious. It can be carried so far that it is injurious not only from a commercial standpoint but from a military one as well; the Germans overtrain troops in this respect. French, English, and American troops are trained so as to increase the individuality and initiative of the men; German troops so as to decrease it. Germany has made her showing on the excellence of her military machine; the Allies, with a vastly inferior machine, checked her because of the superior excellence of the material in theirs. Without sacrificing this superiority of the individual soldier the Allies have been steadily perfecting their machine; we should learn the lesson, and while maintaining the present high standard of our individual soldier should create an efficient machine in which to use him, otherwise he will be simply wasted when the test comes.

Now how do these qualities produced by military training fit in with the commercial life of the nation, which is the normal life for the great majority of the population? In every business the larger part of the work is of a routine character and is duplicated day after day. The special cases requiring individual solution and the emergency cases are few. The soldier has learned the value of a routine for doing daily tasks and he drops into it naturally, while his mind is free to devote itself to the special and emergency cases that arise, and the handling of these constitute his chief opportunity of making a record and securing advancement. The young man fresh from school or college is not accustomed to submit himself to routine and orders and he is in a state of unconscious mental opposition to it. He uses a large part of his mental energy in going through routine work that should require none. Moreover, he is generally lacking in a sense of responsibility for his work, is not accustomed to being held accountable for results and has no initiative in tackling difficult and unexpected situations. Military training tends to develop a man to meet more successfully commercial conditions in these respects. Since one of the fundamentals of the military school is to hold men accountable for results, there is no place where an excuse is of less value. The captain is held accountable for the efficiency of his company, and his plea that inferior men or incompetent officers were furnished him is of no avail; he is expected to make them efficient. This follows all down the line. A corporal sent out on a mission is expected to accomplish it and not blame the deficiencies of any of his men; even the individual private is expected to accomplish a task given him and not to produce instead even the most unimpeachable of excuses for failure. With this system there goes the excellent check that no man is ever supposed to assign to another a task that he would not himself undertake under the same conditions and with the same resources.

It must be remembered that there is as much discipline required and as many orders given in a successfully run business as is required in the management of an Army. The average young man has a tendency to object to both discipline and orders because he feels that they are something personal applied to him and that they place him under the personal control of some other individual. The soldier has learned that both discipline and orders are impersonal and are but part of a general scheme which is required if all are to work together to the maximum efficiency. He knows that his officer is as much under orders as any of the enlisted men and that it is all for the accomplishment of a purpose that is common to all (of them) and in which they are equally interested. He can, therefore, readily realize that the same conditions govern business and that in carrying out orders there is nothing derogatory to his dignity.

Much has been said about the undemocratic tendency developed by army training owing to the emphasis laid on the difference in the status between enlisted men and officers. There is no greater division between the enlisted men and officers than between the status of the officials and the employees of any corporation, if in fact there is as much. The formal military courtesies and models of address required between enlisted men and officers are required to counteract the effects of the too intimate contact brought about between the two by military conditions; and it should not be forgotten that these courtesies are recipocal. It is just as incumbent for the officer to return the salute of the private as it is for the latter to salute; moreover, the salute is not given the officer as an individual but as the incumbent of an office which represents certain delegated authority from the Government of the United States. As a matter of military law every enlisted man has far greater means of protecting himself against unfair treatment and abuse of authority on the part of an officer than has any workman in private employ against the petty abuse of authority of even a foreman. Far closer personal and friendly relations exist between company officers and their men than exist between men similarly situated in private employment. Conditions naturally bring this about as the officers are charged with responsibility for the welfare of their men not only during working hours but for all their living conditions, while in a factory contact ceases with cessation of work for the day. When one has to look after a man's food, clothing, and housing it is natural that a much closer relationship should develop than where supervision of work only is concerned. It is to the great credit of our military system and the officers and men that this should be possible without either the creation of a set of military snobs or the establishment of that type of familiarity bred of a lack of respect, which would soon break down the morale of any army.

A question of importance is the length of time that a young man can give up to military training to the best advantage from a commercial standpoint. This will naturally vary with the individual, as some will acquire all the valuable traits that it is desired to develop in considerable less time than others. It is considered that any young man can profitably spend one year in military training and from that up to two years, according to the individual. That is, considering the five years of a young man's life after he has reached eighteen or ninteen years of age, by what means will he have achieved the greatest commercial success at the end of that five year period. Any young man who devotes his first year to military training and then goes into business will almost certainly be further ahead at the end of the period than if he went into business at once. According to the individual characteristics of the man the time he could profitably devote to military training would probably range between one and two years, the efficient point for the great majority being fairly close to the one year period.

The young man who has finished his school education and then had a year of military training will come to his commercial work well trained to drop into his particular position with the least friction and the least need of adjusting himself to his new environment, consequently he will have the maximum of mental energy free to devote to the development of his own efficiency and the improvement of his work. He will also have the advantage of taking up his work while in perfect physical condition.

As the military experts are satisfied that they can turn out a sufficently well trained soldier in one year, and this period will likewise produce about the most efficient results from a commercial standpoint, the military needs of the country should not prove a commercial burden. It is more than probable that a well worked out system of military training, free from the influence of politics, so far from entailing additional expense on the country will on the contrary pay a very handsome profit on account of the greatly increased economic value of the men who have experienced the training. The valuable results that will be found to accrue from sane military training of young men will be such that it is quite likely to result in a demand that all young men be put through one year of such training, even those physically unfit for soldiers as long as they are strong enough to stand the year's work. *National Service.*

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Co-operation Between Balloons and Artillery

By Major D. Rainsford Hannay, Royal Flying Corps, British Army

It is a very well-known axiom in war that the closest co-operation between the various arms is necessary to secure the best results; and, when it comes to the question of captive balloons observing for artillery, the more that each unit knows about the methods of, and the difficulties experienced by, the other the better.

I propose, therefore, to describe the working of a balloon section of the British Army in the field.

As regards organization, the ballon service of the Royal Flying Corps is divided into wings, companies, and sections. A section consists of four officers and 90 men and works one balloon. A company consists of two sections. A wing consists of all the companies in any one army.

The balloon now in use in the field is a streamline balloon, the invention of Captain Caquot, of the French Army. It has a cubic capacity of 950 cubic metres and is capable of lifting two observers to a height of 4,000 feet. Each section is provided with a mobile winch, the engine of the winch being quite separate from the engine of the truck on which the winch is mounted. Theoretically, the balloon should be let up from the ground at a considerable distance behind the lines and then run forward on the winch with the balloon high up in the air; but, in practice, it is found that there are very few roads left near the lines which are fit for a heavy truck, and, even if one is found, it is probably too congested with traffic. Owing to these reasons, the majority of balloons, in France, are stationary, at an average distance of about 6,000 yards behind the line. Where sections have been able to move their winches forward, they have got within 4,000 yards of the front line.

As regards observation of fire, the work of the balloon observer is chiefly with the heavier pieces of artillery, such as the

6-inch howitzers and the 4.7-inch guns,
8-inch howitzers and the 60-pounder guns,
9.2-inch howitzers and the 6-inch guns,
12-inch howitzers,
15-inch howitzers.

In the earlier days of the war, when there were fewer heavy batteries, balloons used to observe for Field Artillery; but, owing to the great increase of the howitzer batteries, and, also, to the somewhat altered rôle of the Field Artillery, very little work is done with them nowadays. In order to avoid confusion, Field Artillery in the British Army consists of only 18-pounder guns and 4.5-inch howitzers.

The balloon section is connected by telephone to all the batteries with which it is likely to work. The upkeep of the telephone service is most important, and it is necessary that batteries should give as much mutual assistance as possible. Unless the lines are working well, the balloon might as well be on the ground, for all the good it can do. An advantage which a balloon has over an aeroplane, and one that compensates for a great many of the disadvantages, is the fact that the observer in the basket can talk direct by telephone to the battery commander on the ground, and does not have to confine himself to a limited code as used on the wireless. All the telephone lines, with the exception of those to Corps Heavy Artillery Headquarters, are the shooting lines of the section, and are used only when observing for, or when arranging shoots with, batteries. Lines lead from the balloon camp exchange to an advanced exchange which is placed in a central position among the batteries. Now when the balloon is in the air, it is connected by a telephone cable to the winch, which is, in turn, connected by aerial line to the camp exchange, and, tapped in on this line, is the chart room of the section, where all the map work and the arranging of shoots with batteries are done.

I have purposely enlarged on the communications of a section for this reason: although the greater part of the lines are laid by the signal companies, when once laid, the balloon section is responsible for their upkeep, and it is a pretty big job for the small telephone detachment allotted to a balloon section. Therefore it is of the greatest help when batteries assist, as much as is in their power, with the laying and maintenance of the line from their position to the advanced exchange.

The work chiefly allotted to the balloon consits of:

1. Destruction of villages;
2. Destruction of strong points behind the line;
3. Registering on cross roads:
4. Registering on exits from villages, woods, and ravines;
5. Counter-battery work.

The method of observation employed is to observe on the line balloon-target, and, by the use of graticuled glasses, to send to the battery such observations as:

1° 20′ Right,
30′ Left,
Line and over,
Line and short.

Artillery officers will fully realize that it is not advisable to give observations as regards range until the battery drops a shell fairly close to the balloon-target line. Then, when the observer is able to check the range, the battery commander will register by the bracket system, always remembering that to keep his shells falling on the line balloon-target it will be necessary for him to give deflection for each increase or decrease in the range ordered on the guns. This deflection varies according to the size of the apex angle in the triangle balloon-target battery.

The chief object of the observer is to describe to the battery commander briefly, but clearly, the position of each shot. This can frequently be done with reference to surrounding objects in the vicinity of the target. For instance, even when a shot does fall wide of the target, it may be possible to check the range owing to its falling short or over some other object on the map, such as a road, stream, small wood, etc. Here the observer would give such an observation as, "40′ right and short of the small wood N. E. of the target." Such information as this is, of course, very valuable to the battery commander, as he can alter his range and deflection at the same time and thus save both time and ammunition.

I will try and describe a typical shoot on a fixed target, let us say the southern exit from a village including the houses on each side of the road. The night before the O. C. Balloon Section No. 24 (code word HAWK; code words are always used when telephoning near the lines in France) arranges to observe for No. 64 Siege Battery, 12-inch howitzers on railway mounting (code word BRASS) on the southern extremity of the village of Longueval, as soon as visibility permits. When the balloon goes up, and the observer is ready, and can clearly see the target, he sends the following information through the chart room to the battery:

1. Position of balloon. This is done by dropping a small plumb line about 20 feet long over the side of the basket and noting the exact spot over which the basket is hanging.
2. Height of balloon in feet.
3. Strength and direction of wind.
4. When he is ready to observe.

He should also arrange with the battery commander as to the exact reference point from which he will give his observation. In this case he will probably use the spot where the road joins the houses of the village.

The battery will then send to the balloon:

1. Time of flight of shell.
2. Nature of projectile. In this particular case there can be no question, as a 12-inch howitzer fires only high explosives.
3. When they are ready to fire.

When both observer and battery report they are ready, the battery will send, "Stand by," and the observer will then give, "Ready." As soon as "Ready" is received by the battery, the guns will be fired at once and "Gun fired" will be sent to the balloon. —*Aerial Age.*

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Shells That Will Dive

Shells which strike fairly smooth water at an angle of less than nine to ten degrees, if they are provided with an ogival head, will fail to "bite" and will ricochet, or bound from its surface into the air. Sometimes the path described by the ricocheting shell will consist of great parabolas, in which case the shell may travel for a straight mile before it again strikes the water. At other times a shell will travel under and near the surface of the water, raising a line of numerous small geyser effects. The ricochet trajectory depends upon the range and velocity of the shell and the condition of the sea.

For these reasons, much attention has been paid to the problem of devising a shell which, instead of rebounding from the surface, will "bite" the water on striking, and continue its course below the surface. A recent dispatch from Washington states that the problem has been solved and that our ships are provided, or soon will be, with a shell which will dive and strike a submarine, or burst in its vicinity, even though the enemy be below the surface. The shape of the shell cannot, of course, be disclosed at this time.

The periscope is an exceedingly difficult object to hit, and a hit, at any considerable range, even by a first-class pointer, would be a matter more of luck than good shooting. But if the shells are of the diving type it is evident that, by dropping them a little short of the periscope, they would have a fair chance to strike the body of the submarine itself. This is true, even if the line of fire were normal, or approximately normal, to the longitudinal axis of the submarine; but the chances of scoring a hit when the submerged submarine was end on to the attacking gun, would be very favorable, since the danger space would be equal to that of the length of the boat, or say one hundred and fifty to two hundred and fifty feet.

Another advantage of the diving shell is that it can be adjusted so as to detonate when it has penetrated the water to any determined depth. In this case, of course, the action would be similar to that of the depth bomb, which has proved a most effective anti-U-boat weapon.

Thus, by the development of this device, one more peril has been added to the many which surround the under-water sea pirates. What with depth bombs, diving shells, enemy submarines below the water, enemy destroyers and patrol boats on the surface, enemy rapid fire guns on the merchant ships, blimps and seaplanes in the air above the sea, and, most important of all, detectors of constantly increasing range and accuracy—well, the U-boat crews, to say the least, are not having a very happy time of it these days.—*Scientific American.*

SHORT NOTES

Aircraft Against U-Boats.—The following article by C. G. Grey, editor of the *London Aeroplane*, appeared in the *New York World* and was reprinted in *Flying* for May:

"There is a popular illusion, which is not exactly a delusion, that the observer in an aeroplane can see as far down into the water as a submarine is likely to dive. Up to a point this is true, for if the water is clear it is possible to see some 20 or 30 feet into it from a point vertically above, and if such water is only 40 or 50 feet deep a submarine is not likely to dive beyond the visibility point.

"It is quite another matter, however, in the North Sea, where the water is a kind of leaden gray in color and where 10 feet of water over the periscope is enough to hide a submarine as effectually as if she were 20 fathoms down. Therefore, it is fairly obvious that the scouting aircraft have to depend on surface vision quite as much as the patrol boats. Where the difference does come in is in the angle of vision from which that surface view is obtained.

"For instance, a patrol boat might well miss seeing a periscope half a mile away, especially if the periscope were between the boat and the sun, so that the reflection of the sun off the water was dazzling the lookout men. The aircraft observer, on the other hand, perched up aloft, would have a far better chance. The periscope, cutting through the water, makes a very distinct 'wake' which spreads out on each side so that it makes a light but quite distinct 'broad arrow' of foam.

"When the periscope is above water the top of the conning tower is not far below, so that this also is visible unless there is a heavy breaking sea. And probably the bubbles from the exhausting air can also be seen.

"Thus an escort of seaplanes or of the little S. S. Type (or submarine scout) airships which are so familiar to all seafaring people around the British Isles should have a far better chance of spotting the presence of submarines than could any escort of surface ships. At the same time it is well to remember that an escort of 'destroyers' or some similar type of armed ship is necessary, because the aeroplane or airship of to-day is not capable of carrying guns big enough to sink submarines with certainty, and the art of bomb-dropping from aircraft has not become sufficiently a science to make the certainty of the bombs reaching their mark as great as is the certainty of a shell from a 4-inch gun doing so.

"Where the naval aircraft really do come in is in the immense surface of sea which they can cover in a very short time, and their ability to take enemy submarines by surprise while lying on the surface 'airing' themselves and charging up their batteries. A small fast scouting aeroplane does anything between 80 and 100 miles and hour, and at a height of 7000 or 8000 feet it is fairly hard to see. On land one is generally warned of an aeroplane's arrival by the sound of its engines; but at sea the lapping of the water and the whistling of the wind through rigging or round superstructure drowns the sound of the aero engine till it is fairly close. Consequently a seaplane has more than a sporting chance of getting within a mile or so of a submarine before it is seen, and if it gets within that distance it should be able to make things very unpleasant for the submarine, even if it has not the luck to sink it outright.

"A really big fleet of fast aeroplanes patrolling the routes followed by trade shipping and taking aboard their supplies of bombs and fuel from mother ships, of the class officially known as 'seaplane carriers,' should be able to do a great deal toward keeping all submarines well under water during all daylight hours, and one seaplane carrier with half a dozen efficient seaplanes operating therefrom, ought to be able to act by itself as an effective convoy for a flotilla of half a dozen ocean-going tramp steamers, even through waters which were known to be fairly full of enemy submarines.

"Even at night, in moderately fair weather, which is naturally the best for submarine operations, big seaplanes with searchlights could do much to keep the submarines under water, and so add to their troubles by preventing them from stopping on the surface long enough to air their interiors and to charge their storage batteries.

"Neutral shippers traveling up and down the North Sea, have doubtless met big British flying boats at one time or another all over its area, so perhaps one may state definitely that already these big boats patrol regular from the east coast of England to the Dutch coast, near where it joins the German coast. It only needs an extension of such patrol systems to make life on the surface very unpleasant for enemy submarines."

—*Aeronautics.*

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The following letter and General Orders are published by request of the Adjutant General, State of New York:

Editor, Journal U. S. Artillery,
Fort Monroe,
Virginia.

Dear Sir:

The publication of G. O. 14, has elicited the official approval of the War Department and I venture to hope that it will interest you sufficiently to obtain publication in your valued Journal. I also enclose G. O. 13, which will show you that we are doing everything in our power to facilitate transfer from the New York Guard into the Federal service, which from recent reports seem to be taking place at the rate of eighty weekly. Men so transferred are immediately available as noncommissioned officers, something which is so greatly needed in a new army like our National Army.

The State of New York has to date sent somewhat over 180,000 men to the Federal Colors, including our National Guard, our volunteers, and the men chosen under the operation of the Selective Service Law.

Last summer, 4000 Federal troops were guarding the railways and waterways of New York State. They have been released from that duty and the work taken over by the men from the New York Guard, an organization begun during the autumn, and now numbering 18,000 uniformed, drilled, and armed men. In addition to this force, we also have about 10,000 Home Defense Reserve, all excellently drilled and mostly uniformed. We also have 35,000 youths from 16 to 18 years of age, who are so far progressed in their military training as to perform regimental evolutions. This makes a total of 63,000 militarily trained efficients now within the State, which assures ample protection for the railways and waterways of this State, over which there is going abroad through our great port of New York supplies from all parts of the United States to our Allies and troops abroad.

The continuous transport through the State of New York to our port must not be interrupted, and therefore, the New York Guard has not only a State duty, but also one which has a National aspect. In the discharge of this duty they have already received the official approval of the Commanding General of the Department of the East, with headquarters at Governors Island, which approval was published by me in General Orders.

Last Thursday, I called together in Albany a meeting of representatives from all the Chambers of Commerce in the State, in order to receive from non-partisan business experts their business advice upon the administrative problems of this office. Over 200 delegates attended, and an all day session produced many valuable results. It is believed that this is the first time that a military department has requested expert business advice in such manner. The result was so successful, that it is hoped the plan will be followed in other states.

Very sincerely,
C. H. SHERRILL,
The Adjutant General,
State of New York.

STATE OF NEW YORK
THE ADJUTANT GENERAL'S OFFICE

Albany, March 21, 1918.

GENERAL ORDERS,
No. 13.

I. The New York Guard is not only performing a valuable and necessary service in training its members for State duty and in guarding the Barge Canals, the New York Aqueduct, railway bridges and various public utilities and munition plants, but also it is at the same time serving the Nation as a training school for the Federal Army. The value of the New York Guard as such a training school cannot be over-estimated, especially in the preparation of non-commissioned officers, so essential to a new force like the National Army. Many men after a period of training in the State service are enlisted in Federal service—the United States thus obtaining recruits with military experience, and the men thus enjoying a training in the New York Guard fitting them for rapid advancement in Federal service. Men of draft age are also finding service in the New York Guard a useful preparation for their duties after being called to the Federal Colors.

II. It is the desire of this office to facilitate in every way the enlistment in Federal service of members of the New York Guard who are willing to so enlist. With this end in view commanding officers will afford every opportunity to members of their commands for such enlistment, granting them passes for not to exceed twenty-four hours for that purpose if on active duty. Discharges, however, will not be granted until the applicants are accepted for enlistment by a United States Recruiting Officer, and upon receipt of official notice of such acceptance action will be taken as set forth in paragraph III of this order. Commanding officers should also establish cordial relations with United States Recruiting Officers and should co-operate with them in obtaining recruits whenever requested to do so.

III. Upon receipt of official notice either from this office or from a United States Recruiting Officer that a member of the New York Guard has been accepted for enlistment in the Federal service, his immediate commanding officer will at once apply to the proper officer for the discharge of the man from the New York Guard. If the man is on active duty he will be relieved therefrom as promptly as possible. If the man is not on active duty he will be considered as released from state service upon his turning in to his New York Guard company commander, public property in his posession and his discharge will be forwarded as hereinafter indicated. The discharge of an enlisted man accepted for federal service will be forwarded to the United States Recruiting Officer who accepted the man with request that same be returned for cancellation in the event of the man not completing his enlistment in the Federal service.

BY COMMAND OF THE GOVERNOR:

CHARLES H. SHERRILL,
The Adjutant General.

OFFICIAL:

Major, Assistant to the Adjutant General

STATE OF NEW YORK,
THE ADJUTANT GENERAL'S OFFICE

ALBANY, *March* 22, 1918

GENERAL ORDERS,
No. 14.

I. The Regulations for the Military Forces of the State prescribe that deliberations, discussions, statements or remarks, with respect to military matters, whether oral, written or printed, by officers or enlisted men of the State forces, criticising or reflecting upon others in the military service of the United States, are prohibited.

II. While this prohibition is necesary at all times to proper military discipilne, it assumes especial importance in time of war when the entire nation is vitally concerned in military matters. At such a time any real or seeming disagreement or difference of opionin in the military establishment or any critism of or reflection upon those engaged in the conduct of the war, which is given public expression, tends to embarrass the National Government in the exercise of its proper functions and is used by those who would sow discord and dissension among the people, as an evidence of weakness and mismanagement on the part of the Government.

III. It is evident that any violation of this prohibition should be promptly and severely punished during time of war. Under the Articles of War such an offense is punishable by dismissal from the service in the case of officers and dishonorable discharge in the case of enlisted men, and such other punishment as a court-martial may direct.

IV. Members of the New York Guard are hereby directed to carefully observe the provisions of Regulations in regard to this matter. Commanding officers will promptly report any violations thereof. This order will be posted on the Bulletin Boards of all organizations of the New York Guard during the period of war.

By command of the Governor:

CHARLES H. SHERRILL
The Adjutant General.

Official:

Major, Assistant to the Adjutant General.

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THE WAR IN THE AIR

A duel was lately fought in the air between Alexander Shott and John S. Nott. Nott was shot and Shott was not. In that duel it was better to be Shott than Nott, because Shott was not shot. But there was a rumor that Nott was not shot and Shott said that he was not, which proves either that the shot Shott shot at Nott was not shot or that Nott was shot notwithstanding. It may be made to appear in trial that the shot Shott shot, shot Nott, or as accidents with firearms are frequent, it may be possible that the shot Shott shot, shot Shott himself, when the whole affair would resolve itself into its original elements and Shott would be shot and Nott would not. But we believe, however, that the shot Shott shot, shot not Shott himself but shot Nott, and to make the whole statement clear is that Nott was shot by Shott and Shott was not shot by Nott. *Aerial Age*

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FAST SPEED AT FINISHING CAMPS THE MEASURE OF AID U. S. CAN GIVE TO ALLIES

By Hillaire Belloc

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EXTRACT

Now the American service had before it an even harder task than did the British, for its establishment of heavy artillery was much smaller than was the British service before the war. But the American army was found to contain this exceptional and extremely useful item of a coastal defense system, which had not only trained many men in the uses and problems of the largest pieces, but had also centralized a considerable portion of American military thought along those lines. The readers of the exceptionally valuable technical publications such as "The Journal of United

States Artillery" will bear me out when I say that in proportion to the size of the service no army has devoted so much thought to this particular branch as has the United States.

It has proved one of the many cases of unexpected preparation in this war that this branch of the army, created for a totally different purpose, has shown itself of such exceptional value in the present crisis.

Only the other day at Tahure the silencing of the German heavy batteries was accomplished with a rapidity and accuracy that astonished the French, and the work was done by men who had come directly to the West front from the American coastal defense units.

EVEN ERRORS OFTEN VALUABLE.

This unexpected value of preperation in some branch of the service which has come to the front at different timesthrough the developements of the war has furnished some of the most dramatic situations of the last three years.

Extract taken from the New York Tribune of Sunday, March 24.

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A FLASHLESS GUN

Both the French and German armies have been trying for years to discover how to make a gun that shall not merely be noisless, but shall emit no flash. After dark two observers, by watching the time, can with accurate chronometers having luminous dials, discover precisely the position of the enemy battery, or three observers, regardless of time, can do the same by grouping their observations. And this merely by the flash of the guns.

German inventors succeeded, by adding a minute quantity of alkaline salts to their powder, in diminishing the flash, but they found that in proportion as they suppressed the flash they increased the smoke. Other substances added to the powder for this purpose have been vaseline, alkaline soaps, barium, and aluminum. None were successful.

The French tackled the problem as a mechanical rather than a chemical one. A gun is really only an explosion motor, and it seemed that there ought to be a way of muffling its sounds and its flash as those of other such motors are muffled. It was not until 1909, when Maxim invented the silencer, that the problem seemed on the way to solution. Many other silencers, most of which suppress much of the light as well as the sound, have been invented since then, but none is a practical success in warfare.

Arms and the Man.

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FRENCH WRECKERS OF GERMAN DEFENSES

Correspondents on the Western front have been telling us of late that the French army has set aside part of its artillery for wrecking purposes exclusively. When an offensive operation is decided upon, the commander of the *artillerie de demolition* is called into consultation, and to him is entrusted the task of pulverizing and blasting and burying the German works which stand in the way of the attacking *poilus*.

For these wrecking activities the wrecker-in-chief brings up whatever pieces of artillery he deems necessary. These are installed in position with relation to the enemy lines, while railroads are laid and depots are erected for the handling and storing of shells and powder Meanwhile the air service supplies the chief wrecker with aerial photographs of the territory to be treated; and when the fire of hundreds of massed guns is turned on this territory, the aerial photographers continually report the progress of destruction. Such points which hold out longest are subjected to concentrated shelling, while others which have already been destroyed are no longer shelled. A time limit is generally set on this phase of the attack.

A typical of the cannon employed by the French wrecking forces is a powerful howitzer mounted on a railroad carriage to facilitate rapid transportation. The framework over the gun for handling the shells and powder can be lowered and the gun turned horizontally when the piece is en route. A howitzer of this kind, like other French guns, has a remarkable firing rate.—*Scientific American.*

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A QUICK-FIRING CANNON WHICH ADVANCES WITH THE SKIRMISHERS

In order to combat the German machine guns the French of late have introduced in their army a new quick-firing cannon of such construction that it can be readily carried forward by attacking infantry. Thus the skirmishers are able to put enemy machine guns out of action by well-directed shots from their 37-milimeter cannon, which they can carry along with them.

The French "37" is a befitting companion to the famous "75", which has figured so prominently in the French campaigns to date. The smaller weapon has every feature of its larger brother, including quick-acting breech mechanism, accurate sights, and automatic recoil. Lying out on open ground the crew of two men can fire up to 35 high-explosive shells per minute. The shells measure almost 1½ inch in diameter, and the gun has a range well above a mile for accurate shooting. This odd little field piece can be readily taken apart and carried by six or eight men, and is available for use in advanced positions as well as in the open. It is a most workmanlike piece of armament for use under the conditions prevailing on the Western front.
—*Scientific American.*

Notice

Maj. S. G. Shartle, C. A. C., has requested the following corrections be made to his article "Shartle Deflection Board" which appeared in the September-December number of the Journal:

1. Page 210, last line substitute (Fig. 2) for (Fig. 1).
2. Page 211, Subhead D, read (Fig. 3) for (Fig. 2).
3. Page 211, Subhead F, refer to Fig. 3.
4. Page 211, Subhead G, refer to Fig. 3.
5. Page 211, *Note*, refer to Fig. 1.
6. Page 212, Subhead D, *Note*, read Fig. 3 for Fig. 2.

BOOK REVIEWS

The American Soldier in France. By George Nestler Tricoche. Ohio: Edward T. Miller Company, Columbus. 6" x 4½". 105 pp. 1917. Flexible Cloth. Price, $0.50.

A great number of hand books of military French have appeared on the market since the outbreak of the war, and most of them have considerable value to the officer or enlisted man in his dealings with his allies. The book under consideration is very well arranged, neatly gotten up, and contains in its subject matter, arranged alphabetically, such categories as "Artillery "Aviation," "Automobiles," "Cavalry," etc. In addition to these classifications, there are various useful lists such as principal adverbs, principal adjectives, rank, insignia, etc.

There is one defect in this book for which there is no excuse, and that is the lack of accuracy, which was noted in four places. For example on page 7, "la vitesse" is translated "fire for effect" whereas its meaning is "velocity." On pages 28, 64, and 67 reversals occur which would result in the unfortunate error on the part of the unsuspecting American soldier of calling a cat a dog and vice versa, of saying "sleep" for "smell" and vice versa, and finally in using a preposition denoting "by" when he intended to say "for." Such errors undoubtedly detract from the value of the book which otherwise is very good for its purpose.

Grenade Fighting. The Training and Tactics of Grenadiers. By Lieutenant G. Dyson, Brigade Grenadier Officer, British Expeditionary Forces. New York City. George H. Doran Company. 6¼" x 4½". 51 pp. 7 il. 1917. Cloth. Price, $0.50.

Much will be found of interest, especially by artillerymen, in this small volume. The art of constructing the various types of grenades and their loading, fusing, and throwing are discussed with accompanying illustrations. The author declares experience on the Western front has so abundantly proven the necessity and usefulness of the grenade that it is now a highly important feature in combat, and a large number of highly trained specialists in this branch form part of every offensive of the British expeditionary forces. A simple, but technical, treatise is given in each instance and the use of gun-powder, cordite, dynamite, lyddite, trotol, and ammoral fully described.

A grenadier storming party consists of eight men, including two throwers, two carriers, two barricaders, and two bayoneteers. Their methods are given in detail and rules are laid down for the type of grenade to be used under the conditions prevailing in each attack.

Company Training. By Major James A. Moss, N. A. Menasha, Wisconsin. George Banta Publishing Company. 7¾" x 5¼". 123 pp. 6 il. 1917. Paper. Price, $0.50.

Because of the prominence given to the special and abnormal kind of trench warfare developed on the Western front in Europe, declares Major Moss, there is a possibility that many will be misled into training men in trench warfare only and pay little or no attention to open fighting. Major Moss says this mistake was made by foreign armies, but that experience soon convinced them of their error, and that now their officers and men are trained in open fighting, as well as in trench warfare.

Chapters of this work are devoted to the various stages of the company in attack, advance guard action, usual types of defense, and establishing the outpost.

One chapter is confined to the field orders of enlisted men, the preservation of the integrity of the squad in battle, and teamwork back of the firing line.

Hand Grenades. By Major Graham M. Ainslie. New York City: John Wiley and Sons, 432 Fourth Avenue. 7½" x 4¾". 59 pp. 25 il. Buckram. Price, $1.25.

This is a short book of 59 pages which, as the author states in the introduction, contains only that portion of the subject of hand grenades which is considered absolutely essential for anyone having anything to do with their use. In these few pages the author has given a brief, concise description of all the hand and rifle grenades used by the French and British, together with the most common of the German grenades, and an excellent sectional view of each type of grenade is provided. The author has also found room to insert a brief history of the use of grenades in war, the British tactical organization of grenadiers and their employment, a chapter on military explosives, and one on fuzes and primers. This appears to be an excellent book for the purpose for which it is intended.

Topographical Drawing. By Edwin R. Stuart. McGraw-Hill Book Co., New York, and Hill Publishing Co., Ltd., 6 and 8 Bouverie St., E. C., London. 5½" x 8¾". 120 pp. 1917. Price, $2.00.

A general working knowledge of military topography is considered an essential part of the training of the modern officer, and in the years since the Spanish-American war several works bearing upon this subject have been published and have received the approval of the Service. In all of these, however, Root, Beach, and Sherill, the subject of topographical drawing has been treated only in an incidental way. The present work excludes all consideration of field methods, but lays down in an authoritative and comprehensive way the most approved and systematic methods of military map making. Since all field work should be done with a clear understanding of the ultimate value of the data in the finished map a comprehensive knowledge of the most approved drafting room practice becomes of prime importance.

The entire subject of military topographical drawing is covered in a clear and concise manner which makes the work of value alike to the novice and the experienced topographer. The author, who is Professor of Drawing at the United States Military Academy, has made a special effort to standardize the methods and conventional signs used in military map making and it is confidently predicted that the work will become the standard of practice among American officers. The book is profusely illustrated with explanatory drawings and maps, and merits a place in the equipment of every officer.

Lessons in Fortification. Part I. Effects of Artillery Fire; Part II. Field Fortification and the Protection of Batteries. Published by the Press of the Engineer School, Washington Barracks, D. C., 1917. 120 pp. 10 plates.

Now that the duties of the Coast Artillery Corps include the use of heavy artillery in the field, in addition to studying the effects of projectiles on armor, the closest attention must be given to the results obtained with shell and shrapnel with different types of fuses and varying angles of fall when fired on land targets. This pamphlet should be in the hands of all Coast Artillerymen, as it describes in great detail this essential information. The effects obtained with different types of French and German projectiles is fully described. The latest practice with reference to the construction of bomb proofs, gun emplacements, observation stations, etc., are other features of the pamphlet which add to its value as a training handbook for the Coast Artilleryman.

Best O'Luck. By Alexander McClintock, 87th Battalion Canadian Grenadier Guards. New York City. George H. Doran Company. 7½" x 5". 171 pp. Buckram. Price, $1.00.

How a Fighting Kentuckian won the thanks of Britain's King. It is a very vivid picture of "Shrapnell Corner" and is of interest both to the general reader and to the officers of our new army who are preparing to go over to France, as it describes in detail the newest features, systems, and methods in present-day warfare.

The Distinguished Conduct Medal was awarded to Sergt. McClintock for conspicuous gallantry in action. "He displayed great courage and determination during a raid against the enemy's trenches. Later he rescued several wounded men at great personal risk."

Pocket Field Manual. By Captain Geo. R. Guild and Fred C. Test, United States Army. Menasha, Wisconsin. George Banta Publishing Company. 5¾" x 4¼". 184 pp. Cloth. Price, $1.00.

"*Pocket Field Manual*" is a useful book for the company officer, especially those just commissioned, and includes in its pages much that is explanatory of regulations and additional information needed by the officer in the field. Duties of officers and noncommissioned officers are discussed at length, and the important subject of subsistence is exhaustively treated. Military hygiene, rail transportation, care of animals and equipment, and some data on paper work are the other chapters in the book.

How to Live at the Front. By Hector Macquarrie, B. A. Contab., Second Lieutenant Field Artillery. Philadelphia and London. J. B. Lippincott Company. 12 full page illustrations. 269 pp. Cloth. Price, $1.25.

The development of military character rather than an exposition of military doctrine is the purpose of this book which is filled with suggestions for the mental, moral, and physical welfare of the officers and enlisted men in our new army.

Written in an informal and conversational style, the author takes a man from the earliest stages of his initiation into his military career to the trenches, the battery, the observing station, and the other manifold duties that meet him abroad. As a pen-picture of life at the front it is of great interest and well done, and the influence of the book with its plain talk on conditions away from the front should be salutary for the young soldier.

Field Gunnery. By Lieut. D. A. MacAlister, R. G. A. New York City. George U. Harvey, 109 Layfayette Street. 5¼" x 4¼". 153 pp. 89 il. Price, $1.00.

Field Gunnery has become a vital study for the Coast Artilleryman, and this book is instructive in that it describes the methods of the British artillery. The similarity to American methods is patent, but where we use mils the British employ degrees and minutes, and their methods do not seem as simple as ours. However, as noted in the preface by Captain D. W. Hand, U. S. A., "An American officer should be prepared to take over an English battery in action without hesitation," and from that point of view, at least, the manual is useful.

There are chapters on "Mathematical Data of Field Gunnery," "Field Formulae," Ballistics," "High Angle Fire," and numerous other subjects. The book is simply written and explanations are given clearly with many illustrative diagrams.

Topography and Strategy in the War. By Douglass W. Johnson. New York. Henry Holt and Company, 19 West 44th Street. 9" x 6". 211 pp. 48 il. 18 maps. 1917. Price, $1.75.

This is an Analysis of the Topography of each of the Most Important Theatres of War, together with a summary of the Principal Campaigns, pointing out how Military Operations have been influenced by the Surface Features of the country. The author has endeavored to picture the theatres of war and to emphasize the influence of land forms upon military operations.

The Attack in Trench Warfare. By Captain Andre Laffargue, French Army. New York: D. Van Nostrand Company, 25 Park Place. 5¼"x3½". 82 pp. 8 il. Flexible Cloth. 1917. Price, $0.50.

General Joffre thought so highly of the study by Captain Laffargue entitled *Etude sur l'attaque dans la periode actuelle de la guerre* that he caused it to be published to the French Army before it was given out for general publication.

The translation, *The Attack in Trench Warfare,* a small book of eighty-two pages, is written in a very interesting style. It is printed on dull finish paper, 10-point type, and the illustrations are excellent.

This small volume contains much information for those interested in the tactics of the U. S. Platoon offensive.

What Sammy's Doing. By Major Jas. A. Moss, U. S. Army. Wisconsin. Geo. Banta Publishing Company. 7¾" x 5¼". 141 pp. Profusely illustrated. Paper. 1917. Price, $0.75.

What Sammy's Doing approaches a pictorial sketch of the soldier's life. The text is a brief, instructive narrative of the organization and training of the company; it is an excellent book for the recruit to read, and a memento that will prove interesting to the "folks back home."

Surgical Nursing in War. By Elizabeth R. Bundy, M.D. Philadelphia: P. Blakiston's Son and Company, 1012 Walnut Street. 7½" x 5". 184 pp. 37 il. Cloth. Price, $0.75.

Every paragraph in this excellent, readable volume, not only carries important and valuable information to the essential helper of the surgeon, the nurse, but in a concise form gives information about present methods in surgical nursing, developed by experience in the present war which is of extreme value to the physician himself. This work is of such merit that it should be read by all medical men and nurses in army service.

Field Hygiene and Sanitation. By Joseph H. Ford. Philadelphia: P. Blakiston's Son and Company. 1012 Walnut Street. 7½" x 5". 248 pp. 152 il. Cloth. Price, $1.25.

This most concise, brief little volume, gives the essentials of the subject of which it treats, in such a manner, that scarce a word could be spared to further abbreviate the subject. The instructions are very practical and are of recent experience in active field service. The drawings are good and workable. It is very worthy of consideration by those engaged in the service.

Handbook of Antiseptics. By H. D. Dakin and E. K. Dunham. New York: The Macmillan Company, 64-66 Fifth Avenue. 6" x 4¼". 129 pp. 10 il. Flexible Cloth. Price, $1.25.

Just now when there is so much discussion in the Profession, as to the value of the various Antiseptics and methods of treating War Wounds, this little book from so noted authorities, of such wide experience in treating such wounds, is both timely and instructive. The experiments given are conclusive that the Dakin method of wound treatment is effective when properly administered. The method as given should be condensed, printed in pamphlet form, and distributed to every Army Surgeon.

The War of Positions. By Lieut.-Col. Paul Azan, (Chief of the French Military Mission at Harvard University). Massachusetts. Harvard University Press. 7½" x 5¼". 186 pp. Cloth. Price, $1.25.

In glancing over this book written by the Chief of the French Military Mission at Harvard University, it occurs to the reader that here is a substitute for our Field Service Regulations which, designed for open warfare have lost much of their application to the specialized warfare now characteristic of the Western front. The book is worth the closest scrutiny by all officers, as it must rightfully be considered to contain the latest trench war tactics.

Colonel Azan first discusses the character and forms of warfare and combat on a front, then describes the rôles and functions of the different arms of the service. The importance of our own arm, i. e., the artillery, is constantly emphasized by such statements as "Infantry is powerless without the aid of artillery, which shares with it the principal rôle in combat."

The tactics of the various arms both in attack and defense, trench duties, system of reliefs, all come in for illuminating treatment, and the glossary, of unusual French military terms at the end adds not a little to the value of the book.

Manual of Recruit Instruction for Field Artillery. By Major William E. Dunn, F. A. N. A. Philadelphia: J. B. Lippincott Company. 6" x 4½". 96 pp. 1918. Price, $0.75.

This volume contains a schedule of instruction that will prepare the recruit for full duty with the battery. The schedule is progressive; all work is planned so that no time is lost through delay. There is a schedule for each day's instruction, assigning sufficient work to keep everybody busy every minute. The instructor is told exactly what to have his men do, what mistakes to watch for and what points to emphasize. This is the actual course of recruit instruction used by Major Dunn when he was a Battery Commander, and worked into its present shape through actual trial and proof of efficiency. The Battery Commander and non-com, will find it invaluable in their effort to speed up the preparation of their men for actual service. The schedule extends over a period of one month, after which the recruit is ready for duty with the battery.

The Gas Motor. By M. Kushlan. Chicago: Branch Publishing Company. 7½" x 5½". 350 pp. 86 il. 1918. Price, $2.50.

This book does not treat the subject simply from a theoretical point of view as that would limit its use to a few highly trained specialists, but the author has attempted to make this a practical book, by adhering to the fundamental principles rather than details; by avoiding the use of any technical terms without clearly defining their meaning; and, finally, by illustrating these general principles with concrete examples of the most recent applications of the gas engine to stationary power plants, motor vehicles, and aeroplanes.

Scientific Management Applied to Instruction and Training in Field Artillery. By Major William E. Dunn, F. A. N. A. Philadelphia: J. B. Lippincott Company. 6" x 4½". 96 pp. 1918. Price, $0.75.

Officially recommended for publication by the Field Artillery Board; the text of this volume was first printed in the Field Artillery Journal. It gives the scientific and educational principles on which to build a course of instruction. It applies to Field Artillery forces as well as other branches of the service, in the matter of their training; in such problems as eliminating waste of time, effort and property; scientific investigation and measurements; analysis of resulting records and statistics, best methods, standards, directions for performing work, instruction cards, schedules for co-ordinating work; plans and programs, teaching and training; health, welfare, recreation and contentment; inspection and tests, incentives and discipline; organization, management, system;—in fact the volume gives a bird's eye view of the field of efficient handling and training of this vital portion of the service. It is a very valuable book and should be read by every officer, regardless of what branch of the service he may be in.

The Marvel Book of American Ships. By Captain O. P. Jackson and Major F. E. Evans. New York: F. A. Stokes Company. 10″ x 7¾″. 391 pp. Profusely illustrated. 1918. Price, $2.50.

This is a facinating book for all who are interested in the sea. Major Frank E. Evans, U. S. Marine Corps and Captain Orton P. Jackson, U. S. N., authorities on naval matters, describe in detail every kind of ship—the Man-O'-War's-Man, Super-dreadnought, Submarine, Destroyer, Lightship, Liner, Yacht, and Merchantman.

The reader is taken to the great ship yards, where our huge seagoing steamers and fighters are constructed and introduced into the secret of their building. There are vivid accounts of great sea battles, gun firing and signalling, deep sea diving, and countless other subjects connected with the sea.

It contains twelve plates in full color and over four hundred illustrations from photographs. Especially interesting is the chart of the flags used in the signal code and that showing the types of funnels and company flags by which the ships of the various great steamship lines can be recognized.

Elementary Notes for the Field Artillery Driver and Cannoneer. By Lieut.-Col. W. P. Ennis, U. S. A., Philadephiha: J. B. Lippincott Company 6¼″ x 4½″. 110 pp. 1918. Price, $1.00.

As the author states in the preface to the *Elementary Notes for the Field Artillery Driver and Cannoneer,* the book was intended for an abridged text book on the subject. Apparently the author has combined a logical and concise digest of the drill regulations with some ordnance drawings and information on material gathered from the ordnance pamphlet. The book takes up the dismounted drill in detail—also the duties of the various cannoneers during firing—but no attention is given to the most important part of the drivers rôle—i.e.,—handling of horses. There is much valuable information on care of material, and some very useful tables showing the soldiers equipment—and where he carries it—The book should be used to advantage in teaching at Officers Training Camps, at noncommissioned officers classes in National Army, and National Guard Regiments—It is written in a clear simple manner and contains information on the very subjects taught in those camps and schools.

Combined Army Publications. By Colonel J. A. Moss, N. A. Wisconsin: Geo. Banta Publishing Company. 9¼″ x 6″. 835 pp. 1918. Price, $2.50.

The best description of this book is in the words of the preface:

"This book is merely a combination, for the sake of convenience, without any change whatsoever, of the Manual for Courts-Martial, Rules of Land Warfare, Field Service Regulations, Small-Arms Firing Manual, Manual of Interior Guard Duty, and the Uniform Regulations.

Each publication is preceded by its index (by paragraph numbers,) a special index having been prepared by the author in the case of the Manual for Courts-Martial."

It is strongly bound, and printed on a fairly good quality of paper. As the books and pamphlets included are furnished by the Government separately in neatly bound, convenient form, the utility of this particular collection is questionable.

Simplest Spoken French. By W. F. Giese and B. Cerf. New York. Henry Holt and Company. 6¾" x 4¾". 110 pp. 1918. Price, $0.65.

Actual experience in teaching French at Military Camps has laid an excellent foundation for "Simplest Spoken French." As the title implies, it is a text book offering a short cut to a sufficient mastery of the French language as far as ordinary and simple every-day conversation is concerned. It is believed that the manual is well thought out, is very practical even for study by one's self, and if conscientiously used, will certainly give its reader a very valuable knowledge of essentials.

The Richardson Slide Rules. Geo. W. Richardson, Chicago, Illinois.

These slide rules are in principle similar to the ordinary 10-inch rules on the market, but are of novel construction in that the body and slide are formed of pressed steel carrying white celluloid facings on which the scales are engraved. The pressed steel construction is of questionable value, as any serious accident such as jamming or bending would be practically fatal to the proper functioning of the slide. It does, however, render the rule practically immune to troubles from moisture.

Of the set of six different scales, the one most suitable for artillery officers would seem to be the "Pantocrat Mannheim" rule No. 1812, price ($3.00) or the "Polymetric with inverted C scale" No. 1776, price ($3.50). Both these rules have sine and tangent scales, and the former has two log scales, thus making it possible to add and subtract numbers arithmetically.

An easy way is provided for the use of conversion constants by setting an index letter in a reading window at the end of the rule.

They are well worth the price, and are recommended for those officers who do not care to purchase a more expensive rule.

The accompanying book of instructions is one of the clearest and simplest which has yet been published, and describes definitely and in detail every possible operation. It is profusely and clearly illustrated, and will be a valuable source of information for those not thoroughly familiar with the theory and use of the slide rule.

Hand to Hand Fighting. By Captain Haskell C. Billings and Captain Harry B. Johnson, United States Infantry. Wisconsin: George Banta Publishing Company. 5½" x 4¼". 89 pp. Profusely illustrated. Paper. 1918. Price, $0.75.

If you had lost your rifle in the charge and were suddenly confronted by a lunging Bosche, with his twenty inch bayonet on his fifty inch Mauser, would you turn and run? Nothing of the kind! You would sidestep to the right, parry with your left arm, brushing his bayonet aside, dart in, seizing his left wrist firmly with the right hand and grip his rifle with your left, the back of the left hand down. Then you would swing his rifle upward and to the right, at the same time stepping in, but retaining your grasp on your opponent's left wrist, bringing your left knee between his legs and forcing it upward with all the violence you could, after which he could be easily forced to the ground, disarmed, and killed with the butt or bayonet of his own rifle.

This is but one of the many situations for which a complete set of directions are given in this work. Every position is illustrated with a half-tone engraving and formulas for thrusting your bayonet thru your opponent, fracturing his skull, or breaking his back, become, with these rules and illustrations, as simple as performing setting-up exercises at reveille. The scientific methods outlined are not theoretical, but are based on the practical experiences of the authors. Captain Billings was a Captain in the Seventh Reserve Battalion, Canadian Expeditionary Force, and, after two years service at the front, served as bayonet instructor of the Canadian School of the Bayonet, in England, prior to returning to America to join the United States Army. Captain Johnson was a lieutenant in the Black Watch Regiment, and graduate of the British Bayonet School in France, which he attended after receiving two wounds at YPRES and one in the SOMME.

The methods set forth, together with the plans given in the sketches of bayonet assault courses, were those used by the authors during the instruction in the use of the bayonet which they gave at Fort Oglethorpe, Georgia.

Rapid Training of Recruits. By M. V. Campbell. New York: Frederick A. Stokes Company. 5½" x 3¾". 180 pp. 1918. Cloth. Price, $1.00.

The adaptation of this work is based, declares the author, on an English publication bearing the same title. In training American Recruits for war, the author contends, the brutal, crushing methods of the Germans cannot be used. It is his belief that if the will is weakened by fear and fatigue, these weaknesses will predominate when the acid test finally comes on the field of battle. The great principle which the author believes should be borne always in mind by instructors training recruits is that the natural inclination growing out of the instinct of self-preservation must be offset by the acquired inclination to obey commands promptly, steadfastly, and energetically in the face of all dangers that may be encountered. Acquired movements are solely the result of education, and it is this education which is of such vital importance in teaching the young soldier, and instilling into him at the very beginning of his military career, the inclinations which are essential to the success of his commanding officer in the supreme test that is to come. Efficiency, important as it is, becomes secondary to this great principle which the author stresses in his introduction.

In training, a carefully arranged program must be carried out, according to this work. Unless this is done, sufficient variety will not be presented, and the recruit grows stale. This, and many other suggestions, given in detail, are included in the work, together with several Chapters on Company lectures, Schools for Privates and Noncommissioned Officers, Camp Sanitation, Deficiencies of Corporal and Sergeant instructors, physical training, casualty drill, rainy weather duties, and other subjects.

Ordnance and Gunnery. By Lieut.-Col. William H. Tschappat, U. S. Army New York: John Wiley and Sons. 9¼" x 6". 705 pp. Profusely illustrated. Buckram. Price, $6.50.

Since the last edition of Lissak's "Ordnance and Gunnery" five years have elapsed during which there has been rapid development in the types and power of guns and carriages. Colonel Tschappat's new book, which he states in the preface "is largely a revision of Lissak's Ordnance and Gunnery" brings this well known book up to date, and in addition furnishes new material of great value and interest. Thus the system of interior ballistic computations is entirely orignial, and gives theoretical results which are in close accord with results obtained in practice. There is also much that is new and interesting in the chapter on explosives. The chapter on exterior ballistics has been changed to conform with the pamphlet on this subject by Lieut.-Col. E. P. O'Hern, and is consequently more useful than was the corresponding chapter in the old book.

The older officers in the Coast Artillery Corps are too familiar with the volume under consideration to require any recommendation for its use, but to them and still further, for the benefit of the newer officers, it may be said that the new book is undoubtedly the most reliable and up-to-date authority on Ordnance and Gunnery, and goes into all phases of the subjects with great clarity and sufficient detail.

Hand to Hand Fighting. By A. E. Marriott. New York: The Macmillan Company. 6 x 4½. 80 pp. Profusely illustrated. Price, $1.00.

This volume presents a series of positions and holds for the use of the soldier engaged in hand-to-hand encounter. The object of this method is twofold: to disable or destroy the opponent; and to defend oneself. Not since the middle ages has a knowledge of this method of fighting been so essential as it is today in trench warfare. This system of training has been adopted by a number of companies at Camp Sevier, S. C., and has won the praise of all the officers who have had occasion to observe its effects on the men. It is well illustrated.

The Engineers' Manual. By R. G. Hudson, S. B. New York: John Wiley and Sons. 8" x 5". 310 pp. 227 il. Flexible Leather. 1917. Price, $2.00.

Professor Hudson of the Electrical Engineering Department of the Massachusetts Institute of Technology and Harvard University assisted by Dr. Lipka, Messrs. Luther and Peabody of the departments of mathematics, civil and mechanical engineering, has succeeded in compiling a valuable manual of engineering formulas and constants.

Formulas of the various branches of mathematics, mechanics, hydraulics, heat, and electricity, ordinarily scattered through a number of volumes have been arranged in the one pocket-sized volume.

The presentation of material is excellent, the main subjects being divided into their various branches, well indicated, and the formulas of each subdivision placed in a sequence based generally upon the order of their derivation. Consequently the desired matter can be easily located. Derivations, considered non-essential for the purpose of the book, have been omitted, but the meaning of all symbols and the use of the formula is clearly indicated.

The book is concluded with a useful series of mathematical tables and an excellent alphabetically arranged list of conversion factors.

The Engineers' Manual will be a great aid to any one engaged in mathematical or engineering work.

Military and Naval Recognition Book. By Lieutenant J. W. Bunkley, U. S. N. New York: D. Van Nostrand Company. 7" x 5". 223 pp. Profusely illustrated. 1918. Price, $1.00.

This is a handbook on the organization, insignia of rank, and customs of the service of the worlds important armies and navies. It is of interest not only to those in the Military and Naval service but to the laymen who, since the beginning of the war, have shown such keen interest in the uniforms, insignia, and customs of our fighting forces. Special stress has been laid on the insignia of rank which is shown in the most minute detail.

Naval Power in the War. By Lieutenant Commander, Charles Clifford Gill, U. S. N. New York: George H. Doran Company. 8" x 5½". 224 pp. 10 maps. Profusely illustrated. Price, $1.25.

A clear record of the naval grand tactics of the war and their results, which will be of great value both to the professional and to the general reader. The book has been adopted by the Academic Board of the U. S. Naval Academy for use in the history course for midshipman.

The chapters describing submarine operations and how we fight the U-boats will be of unusual interest to the general reader.

Radio Communication. By John Mills. New York: McGraw-Hill Book Company. 7¼" x 5". 205 pp. Profusely illustrated. Flexible Leather. Price, $1.75.

Departing from the usual treatise on Wireless Communication, the author has limited this book to a concise presentation of his subject unpadded with elementary discussions of electricity and theories of magnetism.

With the exception of two chapters on alternating currents and the production of damped sinusoidal waves, the treatment is essentially non-mathematical. It is, however, distinctly analytical thruout, and the phenomena of periodic electromagnetic wave production, propagation, and detection, are developed thru the application of fundamental principles.

The analysis of these phenomena, in many cases clarified by vector diagrams, occupies the greater part of the book, the author's intention being to present the principles in a way that can readily be applied to practical methods without burdening his treatise with descriptive matter, which might properly be furnished by the manufacturer. However, the principal types of apparatus and methods are discussed in some detail.

An appendix is added, in which the methods developed in the body of the book are applied to communication over wires. This is considered a special case of Radio Communication in which the propagation of magnetic disturbances is restricted to a metallic conductor.

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JOURNAL OF THE UNITED STATES ARTILLERY

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JOURNAL UNITED STATES ARTILLERY

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1918

The JOURNAL U. S. ARTILLERY announces the following for its annual competition.

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One hundred and fifty dollars will be given for the best essay and one hundred dollars for the second best essay submitted on any coast defense subjects.

CONDITIONS OF THE COMPETITION

(a) Competition will be open to all readers of the JOURNAL.

(b) Award will be made by a committee of award, consisting of three persons, to be nominated by the Coast Artillery School Board. If no essay submitted seems to the committee worthy of a prize, none will be awarded. Honorable mention may be made of any essay submitted which seems to the committee worthy thereof, but to which a prize is not awarded.

(c) All essays entered in competition will become the property of the JOURNAL OF THE UNITED STATES ARTILLERY. These will be published, if approved by the Coast Artillery School Board.

(d) Copy must be typewritten, with lines double spaced, on one side of the paper only, and must be submitted in triplicate. If illustrations are included, one of the three copies thereof must be in the form of drawings, tracings, or photographs (not blue-prints nor brown-prints).

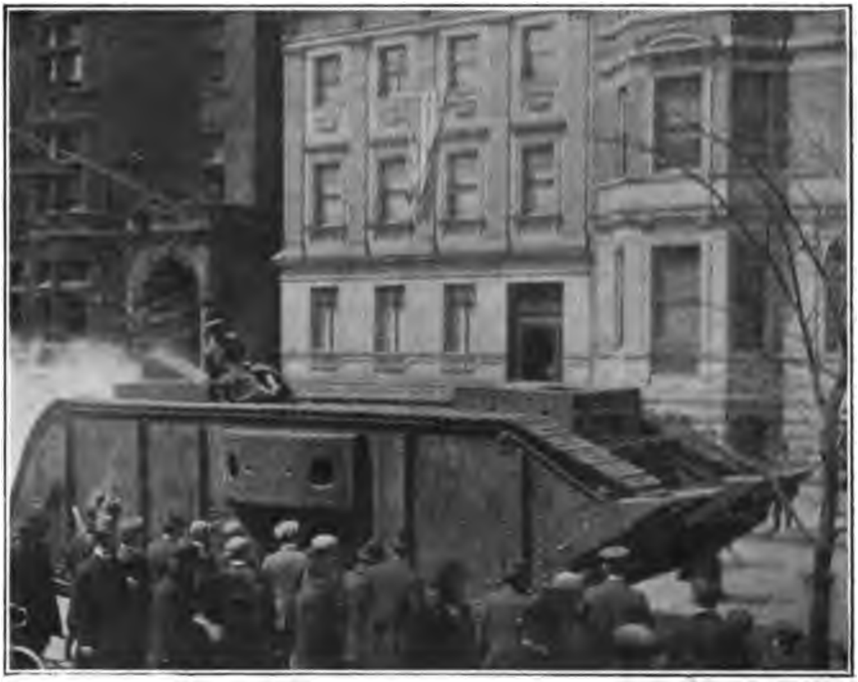
(e) Copy must contain nothing to indicate its authorship, must be signed with a *nom de plume*, and must be accompanied by a sealed envelope containing this *nom de plume* and the name of the writer. This envelope will remain in the hands of the Editor of the JOURNAL and, after award has been made by the Committee, will be opened in the presence of the Coast Artillery School Board.

(f) Copy must be received on, or before, December 31, 1918. It must be addressed JOURNAL U. S. ARTILLERY and the envelope must bear the notation, "Essay Competition."

NOTICE

The JOURNAL U. S. ARTILLERY desires to receive from its readers titles of subjects which they consider would be of interest to the service. A title will be published (either on the "Prize Essay" announcement page or immediately following "Short Notes") until a paper on that subject has been received.

Frontispiece



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"WAR TANK AMERICA."

JOURNAL

OF THE

UNITED STATES ARTILLERY

VOL. 49, NO. 3. MAY-AUGUST, 1918 WHOLE NO. 149

First Steps Towards a System of Target Practice and Fire-Control for Sea-Coast Artillery

By Major-General J. P. Sanger, U. S. A., Ret.

My attention has been recently directed to the January-February number of the ARTILLERY JOURNAL, 1913, containing an article by Captain H. L. Morse, C. A. C., entitled "The Evolution of our System of Position-Finding and Fire-Control." Captain Morse dates these changes from G. O. 108, Headquarters of the Army, December 7, 1888, and although he refers to the efforts of individual officers in this direction, he entirely overlooks what had been done, previously, at the Headquarters Division of the Atlantic, in the years 1886-87-88. With a view to supplying this information, and thus comcompleting the historical record on this subject, in chronological order, this account has been written.

It may be said that by 1886 the sea-coast artillery, in general, had reached the lowest point in its history, and the field artillery was very little better, and while the influence of the Artillery School, re-established in 1868, had been improving to the personnel, the material remained practically as it had been and, with the exception of Fort Monroe, no artillery post was equipped with the appliances necessary for a complete course of instruction as then contemplated. Artillery target practice was under the control of the Ordnance Department, and was notoriously neglected, all that pertained to the subject being covered by Article XXXVIII of the Army Regulations of 1881.[1]

It is not to be inferred from this that our artillery officers were oblivious to the inferiority of our artillery material, and to the moribund condition of its personnel, or that no efforts were made to escape from the professional slough of despond into which we had fallen.

But the great service of the field artillery during the war had been forgotten. Many of the ranking officers of artillery had left it by transfer, retirement, or death, and of the remainder, those who had held high commands during the war, took but little interest in artillery affairs, which they relegated to their subordinates, and, figuratively, washed their hands of the whole business contented to be what they were, "red-legged infantry." There were a few officers, however, notably at Forts Monroe, Hamilton, and Wadsworth, who, while deploring the state of the case, made an effort to better it. As they had failed to enlist the interest of those high in authority, however, and lacked an intermediary capable of doing so, the benefit of their efforts was limited to the places where they were stationed, and the condition of the artillery as a whole was but little better than it had been during the previous twenty years.

It was just at this time that Major-General John M. Schofield appeared, and by his advice and assistance gave impetus and direction to the movement which finally led to the emancipation, but not the complete rehabilitation, of the artillery in its proper sphere of duty; the Ordnance Department still exists, and claims scientific control over all artillery material.

In the month of June, 1886, he arrived at Governor's Island and assumed command of the Division of the Atlantic, made vacant by the death of General Hancock. As General Schofield had been an artillery officer, and as four of the five regiments of artillery were serving in his division, he was naturally much interested in their condition, and in that of the fortifications along the sea front, but had no precise knowledge of them, except as gathered from the statements of artillery officers. I think he regarded their statements as somewhat exaggerated, nevertheless, he was sufficiently impressed to decide on an investigation and an effort to improve matters.

---

[1] In this connection, Captain Morse was mistaken in supposing that mapping the harbors and dividing them into one-inch squares was covered by par. 464 of these regulations. (See his article already referred to).

Meanwhile, many questions of paramount importance engaged his attention, and it was not until the following spring that he was prepared to take a definite course. Towards this end he was greatly assisted by valuable information, bearing on the subject, collected and tabulated during the winter months.

In order to arrouse the interest of the officers by opening the way for suggestions, and to prepare them, somewhat, for the changes contemplated, the following circular was published:

HEADQUARTERS DIVISION OF THE ATLANTIC
GOVERNOR'S ISLAND, NEW YORK CITY,
March 23, 1887.

CIRCULAR.

In order that the annual artillery target practice prescribed in Art. XXXVIII, Army Regulations, may be uniformly conducted throughout this Division, all officers who desire to do so are requested to submit recommendations having in view such a programme as will insure the most thorough instruction in this important subject.

Aside from the firing, which will be direct, curved and vertical, the system should embrace range and position finding, and practice at stationary and moving targets.

While the armament of the various fortifications of the Division is of but little practical value for war purposes, it is our duty to act upon the presumption that this will not always be the case, and to prepare the troops for a more effective armament when it shall be provided. For this purpose every artillery post will be furnished, as far as practicable, with the various sea-coast, siege and field pieces, and with Coehorn, 8, 10 and 13-inch mortars, together with the necessary implements, equipments and ammunition for their service.

In forwarding the suggestions herein requested, post commanders will report what facilities are needed for the thorough and complete instruction of their commands, and to what extent target practice at their posts, with the various guns and mortars, is practicable.

Attention is especially directed to paragraph 464, Regulations of 1881, which will be carefully observed by the commanders of all posts to which it is applicable.

BY COMMAND OF MAJOR GENERAL SCHOFIELD:
WILLIAM D. WHIPPLE,
Assistant Adjutant General.

In reply to this circular various plans for conducting the target practice were proposed and considered, but nothing which could be used as the basis of a system of fire control, which it was hoped might result directly from a careful consideration of the subject. It was finally decided, therefore, to adopt tentatively the defensive plan then followed in the harbor of Cronstadt and elsewhere, suggested by Captain Sanger, but recently returned from a tour of artillery inspection of foreign armies, as the companion and assistant of that very able and distinguished soldier, the late Major-General Emory Upton. This is known as the system of squares, and the plan followed is set forth in the following order:

HEADQUARTERS DIVISION OF THE ATLANTIC,
GOVERNOR'S ISLAND, NEW YORK CITY.

GENERAL ORDERS
No. 11. August 27, 1887.

To ensure the thorough and uniform execution of so much of Article XXXVIII., Army Regulations, as refers to artillery target practice, the following instructions will be carried into effect by the artillery troops of this division:

I. There shall be established at every garrisoned artillery post having a battery of sea-coast or siege guns, or the necessary emplacements for such guns, one or more carefully measured base-lines, of suitable length, the extremities of which shall be permanently marked, placed under cover, and otherwise made suitable for the use of angle-measuring instruments. The azimuth of these base-lines shall be determined as accurately as possible, either by direct observation or by connection with points already well determined by reliable surveys. Adjacent forts located relatively as are Forts Hamilton and Wadsworth, Wood and Columbus, Schuyler and Willet's Point, will be connected by a base-line in addition to their local bases, so that each garrison may have the benefit of the firing executed by the other, and to effect a concentration of fire in case of necessity.

II. The direction of the base-lines shall be such as to make them available for tracking and locating vessels which may enter the waters commanded by the guns, and in locating the shots which may be fired in the annual artillery target practice. If there be not suitable instruments at hand for the determination of the base-lines, a request will be made by the post commander on the nearest engineer station for the loan of the necessary instruments, when, if they cannot be had, application will be made to these headquarters.

III. As soon as established the base-lines will be plotted on the chart required by paragraph 464, Army Regulations, to be kept at all posts having batteries bearing upon a channel, a tracing of which will then be forwarded to these headquarters. The chart will also show the position of the batteries, the outline of the shore for a distance of at least three miles, the shoals, reefs, islands, light-houses, buoys, beacons, fog-bells, spindles, etc., which may be useful in quickly determining distances.

IV. From the chart above referred to each post commander will cause to be prepared a similar chart or map of the harbor or water channels within range; this will be divided into one hundred yard squares, which will be numbered along the upper margin from left to right and along the side from the top down. Tables will then be prepared showing the direction and distance from each gun to the centre of each square, so that a gun may be pointed in the direction of any square with the elevation corresponding to the distance of that square.

The use of these squares in directing the fire of the guns is evident; the vessel having been located at the plotting table, which is ruled in corresponding squares, the square in which she is, is telegraphed signalled or telephoned as 1-1, 3-6, 4-2, etc., when all the guns can be fired simultaneously at that square.

While this method of directing the fire of the guns is suggested, the officers are encouraged to devise other methods having in view the same object.

V. The commanders of the artillery posts referred to in this order which are not provided with angle measuring plane-tables, and who have not already done so, will prepare and forward ordnance requisitions for them without delay. These requisitions will also embrace the other articles enumerated in Appendix A, page 131, Report of the Chief of Ordnance, 1884.

In the meantime, as some delay is probable in supplying these articles, plane-tables, and an anemometer similar to that designed by Lieutenant *Whistler*, 5th Artillery, and now in use at Fort Wadsworth, will be improvised of such material as each post can provide.

VI. While the foregoing arrangements are being made, systematic and careful instruction will be commenced in calculating tables of ranges, in judging-distance drill, and in estimating and determining the distances to all buoys and other objects within range of the batteries.

VII. When the necessary arrangements have been completed target practice will be commenced at the various posts, which will conform as far as the means at hand will allow to the method heretofore adopted at Fort Hamilton, New York Harbor, and published in the Report of the Chief of Ordnance for 1884.

VIII. Great care will be taken in teaching non-commissioned officers and such privates as may be able to learn, the principles of graduating sights, pointing guns and mortars, and the causes which affect the flight of the projectile, especially those due to improper loading, the rifling, and the wind. In every instance before a shot is fired the probable amount of deviation to the right or left as well as in range will be noted, and compared with the result when obtained.

IX. The gun detachments will be practiced in traversing the guns, so that they will remain accurately pointed on a passing vessel, in estimating the time required at her rate of speed in crossing a single square, and the necessary allowance to be made therefore in aiming.

X. When the exercises connected with the annual target practice commence, all other tactical instruction will be suspended, and it is directed that the target practice with any particular piece be always preceded by the most careful instruction in the manual.

XI. The prescribed report of the firing will be forwarded to these headquarters within ten days after its completion, and will be accompanied by a plotting of the shots. Such other reports or forms as may be adopted will also be submitted therewith.

With the present imperfect appliances a *system* of heavy gun practice may be established, under which valuable instruction may be given, which will become more perfect with the acquisition of new guns, implements, equipments and instruments.

By command of Major General Schofield:

Official: WILLIAM D. WHIPPLE
(Signed) JNO. PITCHER, *A. D. C.* *Assistant Adjutant General.*

In order to head off, as far as possible, the opposition and unfriendly criticism sure to follow such an abrupt and radical departure from the leisurely and haphazard way of the past, and to emphasize the invitation to the artillery in the circular of March 23, a proof-copy of the above order was sent not only to all meritorious officers but to those who, it was believed, would oppose any change likely to disturb the lazy life to which they were accustomed.

"Why in h--l can't they leave us alone!" remarked one of them on reading his copy of the proof, and he never ceased to damn the enterprise while he remained a battery commander, which, fortunately, was not for long thereafter.

Notwithstanding the sinister views and expressions of this officer, which were no doubt shared by others, the proof copies of the order sent out were returned without a single adverse criticism, it being understood that the proposed system was experimental, and to be viewed in that light. Evidently everyone thought it was worth a trial.

To further the interests of post commanders, ever tenacious of their high prerogatives, and to add to their responsibility in the conduct of the practice, it was deemed advisable to issue the following circular:

HEADQUARTERS DIVISION OF THE ATLANTIC,
Governor's Island, New York City.
August 30, 1887.

CIRCULAR.

The Secretary of War having authorized the Division Commander "to direct that the heavy artillery target practice in this division be carried on at such time as he may find to be practicable," artillery post commanders will report without delay in what months the practice at their posts can best be had, having special reference to the presence of shipping and the commercial characteristics of the harbors. The winter and early spring as well as summer and fall will be considered in this recommendation as suitable seasons for practice.

Until the reports called for in this circular are received, and instructions based upon them are issued from these headquarters, the autumn practice will be limited to the preparatory work prescribed in General Orders No. 11, current series of 1887.

By command of Major General Schofield:

WILLIAM D. WHIPPLE,
Assistant Adjutant General.

The replies to this circular having been received, the following general orders were issued:

HEADQUARTERS DIVISION OF THE ATLANTIC,
GOVERNOR'S ISLAND, NEW YORK CITY.

GENERAL ORDERS
No. 12. September 10, 1887.

I. Under the authority of the Secretary of War, heavy artillery practice will be conducted this year at the various artillery posts of this Division as follows:—

Fort Preble, from October 15th to November 15th.
Fort Warren, from October 1st to October 31st.
Fort Adams, from October 1st to November 30th.
Fort Trumbull, from December 1st to December 31st.
Fort Schuyler, from December 1st to December 31st.
Fort Columbus, from October 1st to November 30th, at Forts Hamilton and Wadsworth.
Fort Hamilton, from October 1st to November 30th.
Fort Wadsworth, from October 1st to November 30th.
Fort McHenry, from December 1st to December 31st.
Washington Barracks, from October 1st to November 30th.
Fort Monroe, as prescribed in Regulations of Artillery School.
Fort Barrancas, from October 1st to October 31st.

The garrisons of St. Francis Barracks, Mount Vernon Barracks, Little Rock Barracks, and Newport Barracks will practice with field and machine guns, provided suitable target grounds can be found within a reasonable distance of their respective posts.

The garrison of Jackson Barracks, having executed their annual practice at Pass Christian, are exempted from the requirements of so much of this order as refers to firing.

Should it be found impracticable from any cause to complete the annual target practice by December 31st, 1887, it will be continued in January and February, 1888.

II. Referring to general orders No. 11, current series, from these headquarters, and to the map system therein required, it is ordered that in preparing the chart mentioned in paragraph IV. of said order, the scale of 100 yards to the inch be adopted. A tracing of this map will also be forwarded to this office.

III. In graduating traverse circles they will be regarded as complete circles, no matter what their length of arc, and the zero will be in the meridian line at the north point, the graduations being made to the right up to 360°.

No method of marking the graduations, which should be at least one degree apart, is suggested, as it is presumed experience will best determine this, as well as some form of vernier for smaller readings.

IV. In conducting target practice the following instructions will be observed:

1. Each battery commander will superintend the firing of his battery, and will be held responsible for the execution of all the details connected therewith, and for the prompt rendition of all required reports.

2. The preliminary arrangements, except stationing the officers and men and placing floating targets, will always be completed the day preceding that on which the firing is to take place.

3. On the day of practice the officers, men and targets shall be stationed so that if the range be clear of obstacles the firing may begin at the earliest practicable hour in the morning. Three floating targets 10ft. x 10ft. in size, will be kept in readiness at each post, so that no delay on that score need occur. At posts provided with steam launch service the target in use will be brought in and placed under proper guard at night, if necessary.

4. Before the firing begins, and after its termination, every officer and sergeant will inspect the gun, the carriage, the platform, implements and equipments, and will make a written report on their condition to the commanding officer. These reports will be forwarded to these headquarters, and will state damages, accidents, etc., together with any suggestions for the improvement of the ammunition, the material, or the drill, to which the practice may give rise.

5. During the practice no projectile will be fired directly over a vessel, or when there are vessels or boats near the line of fire; nor will case-shot or loaded shell be fired when vessels or boats are near enough to be in the least danger of injury.

6. All charges and projectiles will be *weighed*, and the weights compared with those given in the books and derived from calculation.

7. In the practice with guns the firing will take place at 1,200, 1,700 2,200 and 2,700 yards, and no battery will be permitted to fire at the longer distances until the firing at the next shorter distance has been satisfactory. With this exception the shots will be proportionately divided between the four distances. Only 10-inch and 15-inch S. B. guns and the 8-inch rifled gun will be used in heavy gun practice. At posts not provided with all the above calibres the firing will be executed with such of them as are available, the rifled guns being used at the two longest ranges when practicable.

By observing these regulations the practice will be made instructive and uniform, and the results may be compared as in small arm practice. It may be observed in this connection that close work with a small number of shots should be considered a better record than average work with a large number.

8. The figure of merit will be by battery, and will be based on the mean deviation as indicated by the plotting and record of firing.

9. At posts provided with electric batteries and a sufficient amount of wire, the season of practice will conclude with one or more volleys to be fired by the post commander, and to include such guns as he may designate. Owing to the small number of projectiles for practice, blank cartridges alone will be used in volley firing, but all the guns will be directed at the same object or square, and their position will be verified after the volley is fired.

VI. In forwarding the completed report and plotting of the firing, the original data from which they are compiled will be sent with them for comparison and replotting at these headquarters; they will be returned for file at the post. Should it be found impracticable to execute this order in any of its details, the reasons therefor will be promptly communicated to these headquarters.

Owing to the present deficiencies in the armament of some of the forts the firing must of necessity be somewhat tentative, and a satisfactory comparison of results difficult. But all should direct their attention towards the necessary *preparations* and the establishment of *a system* of heavy gun practice suitable to the defence of our harbors, which can be put in complete operation at every post as rapidly as the necessary material is supplied.

The Commanding General takes this occasion to remark on the very great value to the artillery of systematic target practice. No claim to proficiency can be sustained by artillery troops not skillful in the use of their guns, and this in itself should be sufficient to inspire every officer and enlisted man with an earnest wish to become a good marksman.

By command of Major General Schofield:

WILLIAM D. WHIPPLE,
Assistant Adjutant General.

As the time approached for the annual report of the Division Commander to The Adjutant General of the Army, a *résumé* was prepared of what had been done in the matter of target practice during the year. As much of the subject-matter of this report was collected in 1886 and greatly influenced General Schofield to pursue the course finally taken, no apology is considered necessary for its publication:

HEADQUARTERS DIVISION OF THE ATLANTIC,
Governor's Island, N. Y. H., April 27th, 1888.

To the
Assistant Adjutant General,
Division of the Atlantic.

Sir:

I have the honor to submit the following résumé of the measures adopted by the Commanding General during the past year to establish a general system of instruction in artillery target practice, as also a system of heavy gun firing suitable to the defense of our harbors.

THE CONDITION OF THE SEA-COAST ARMAMENT.

The first step was to obtain correct information of the armament of the several forts along the coast and the condition of the guns, carriages and platforms, respecting which but little was known at Division Headquarters.

This information was carefully arranged and is appended to this report as "A."

From this it became apparent that the armament of but few forts embraced the necessary calibers, and that a large majority contained none of the guns adapted to target practice, or which would constitute our main reliance were we suddenly called on to defend our ports against a hostile fleet. For example: of the garrisoned sea-coast forts, neither Adams, Trumbull, Columbus, nor Barrancas have the 8-inch M. L. Rifle, the most effective of our muzzle loaders. While at St. Francis Barracks, Mount Vernon Barracks, Jackson Barracks, Newport Barracks, Little Rock Barracks, and Washington Barracks there are no sea-coast guns of any calibre.

This difference in armament rendered it impossible to prescribe rules of general application, or to conduct the proposed firing uniformly at the several stations; nevertheless the great professional value of the subject, the fact of its partial disappearance from the duties of our artillery garrisons, notwithstanding its imperative claims upon the time and attention of artillery officers, left no room for doubt respecting the duty of giving it full and prompt consideration, and hence it was believed advisable to proceed regardless of unfavorable conditions, and to rely on the War Department to remedy the deficiencies as far as possible when they should be brought to notice.

As without the hearty co-operation of post commanders and their subordinates, but little could reasonably be expected in view of the present condition of the artillery material in use, it was deemed advisable to issue a circular explaining what was intended and inviting suggestions from all officers in the hope of securing a concurrence of opinion respecting the best course to adopt with the means at hand. Accordingly Circular of March 23d was sent out. To this circular many replies were received, a sufficient indication that no matter how much appearances were against it, all interest in the subject was not dead.

TARGET PRACTICE DURING THE PAST TEN YEARS.

For some idea of the situation, attention is invited to table (pp. 136-137) showing the target practice of the four regiments serving in this Division during the past ten years.

From this table it appears that of the forty-five batteries of artillery serving in the Division, comprising seventy-five per cent of the entire artillery troops of the army, only the two batteries continuously at Fort Monroe have had annual target practice during the past ten years, and, under the system pursued at that school, only a small per cent of the enlisted men of those batteries have had the full benefit of the firing each year. Of the remaining batteries, three have had practice during nine years, one during eight, one during seven, two during six, eight during five, five during four, six during three, eight during two, four during one, and five batteries have not fired a shot from any gun whatever.

MAPPING THE HARBORS

As it was desirable that any system which might be established should be applicable to garrisons and forts of the largest size, and have in view not only perfect skill in gunnery, but the proper artillery defense of our ports against foreign ships of war, it was ordered that all the harbors be mapped and laid out in squares as the first step towards the location of objects on the waters adjoining the forts, and the necessary direction and concentration of fire even when such objects were not visible from the guns. To this end General Orders No. 11 of 1887 were issued, which embraced this and such other instructions as seemed pertinent to the inauguration of the system then under consideration by the Commanding General.

In adopting the method by squares the fact was not overlooked that other methods of subdividing the harbor charts were practicable, such as radii and the arcs of circles, but they were open to many objections not applicable to squares, which have the great advantage of uniform and equal areas, almost indefinite extension, and easy and suitable designation. Besides it was known that squares were the basis of foreign systems of harbor defense long established and thoroughly perfected, and therefore in a measure not experimental.

Much difficulty was experienced in obtaining these maps, owing to insufficient means, and some of them are the result of private generosity on the part of the officers themselves, who purchased the necessary materials for their preparation.

The maps of all the harbors having garrisoned forts are now completed, but will require revision if made to conform with Lieutenant Foote's suggestion of orienting the squares and establishing an initial point in each harbor, the meridian and latitude of which shall be taken as lines of reference. "By this method previous surveys may be most readily utilized, as they must all refer either to this set of co-ordinate axes or to a parallel set." This subject is now under consideration.

THE PRACTICE SEASON

As the season for artillery target practice prescribed in the Army Regulations conflicted with that set apart for the small-arms practice, and was for other reasons unsuitable, application was made to the Secretary of War for authority to change it. This having been granted, artillery post commanders were ordered to report during what months target practice could best be had, bearing in mind the presence of shipping and other commercial characteristics of the harbors. (Circular of August 30th, 1887.)

The replies to this circular suggested many obstacles in the way of the practice, and only added to the difficulties already encountered. For example, the commanding officers Forts Adams, Trumbull, Schuyler, and St. Francis Barracks, at which posts there had been no practice for several years, reported that no firing could take place at any time without danger to vessels and boats. The commanding officer Fort McHenry reported that he had received a protest against firing from the Harbor Board of the city, on the ground that the moral effect of merely knowing that guns were to be fired would alarm the mariners of the port of Baltimore, and be injurious to the commerce of the city. In consequence of this the commanding officer suggested that the firing take place at Fort Carroll, five miles below the city.

The commanding officer Washington Barracks recommended that the garrison of his post execute their firing at Fort Monroe. The commanding officers Newport Barracks, Little Rock Barracks and Jackson Barracks reported no ranges available.

These replies were subsequently modified in part by the commanding officers of Forts Adams and Schuyler, and firing took place at the latter post in the month of February, 1888. The practice at Fort Adams for the year 1887 will take place in May of this year. Arrangements have also been made for the practice of the garrisons of Fort McHenry and Washington Barracks. In this connection it is respectfully suggested that at no sea-coast fort in this Division except Fort Columbus is the danger to shipping sufficiently great to warrant the entire suspension of artillery target practice. There are certain seasons in which the commerce of all our harbors is comparatively light, and certain hours in every day during those seasons when some portion of the waters are entirely free from the presence of boats or vessels of any description, and it would therefore appear that even the remonstrances of the harbor authorities should be no bar to the regular annual target practice at all forts upon which the Government expects to rely in time of war.

"Apart from the necessary drills, it is of very great importance that the

BATTERY.	YEARS DURING WHICH ARTILLERY PRACTICE HAS TAKEN PLACE.										REMARKS.
					1ST ARTILLERY.						
G	1878	1879	1880	1881	1882	1883	1884	1885	1886	1887	Stationed at Fort Monroe, Va.
					2D ARTILLERY.						
A		1879	1880								
B	1878	1879	1880					1885	1886	1887	
C		1879	1880						1886	1887	
D									1886	1887	
E											
G											
H		1879	1880					1885	1886	1887	
I										1887	
K	1878	1879	1880	1881	1882	1883	1884	1885	1886	1887	Stationed at Fort Monroe, Va.
L	1878	1879	1880								
M			1880	1881							
					3D ARTILLERY.						
A	1878	1879	1880	1881	1882	1883	1884		1886	1887	Stationed at Fort Monroe and Washington Barracks.
B											
C	1878	1879	1880		1882						
D										1887	
E	1878								1886	1887	
G										1887	
H									1886	1887	
I										1887	
K									1886	1887	
L									1886	1887	
M								1885		1887	

4TH ARTILLERY.

A		1879	1880	1881			1884				
B	1878			1881			1884	1885			
C	1878	1879	1880	1881			1884				
D											
E	1878			1881							
G											
H						1883	1884	1885	1886	1887	
I	1878	1879	1880	1881	1882	1883	1884	1885		1887	Stationed at Fort Monroe, Va.
K						1883	1884		1886	1887	
L	1878	1879	1880								
M		1879		1881	1882	1883	1884			1887	

5TH ARTILLERY.

A							1884	1885	1886	1887	
B	1878	1879	1880		1882	1883	1884	1885	1886	1887	Fort Wadsworth, N. Y. H.
C	1878	1879						1885	1886	1887	
E							1884		1886	1887	
F				1881				1885		1887	
G					1882		1884	1885		1887	
H							1884	1885	1886	1887	
I					1882	1883	1884	1885		1887	
K							1884		1886	1887	
L	1878	1879	1880			1883	1884	1885	1886	1887	Fort Hamilton, N. Y. H.
M	1878				1882	1883	1884	1885	1886	1887	Forts Hamilton and Schuyler.

officers and men of every important fortification make themselves familiar with the channel ways, and the ranges to all objects within reach of their guns, and that the latter, together with their carriages, platforms, implements and ammunition be maintained at all times and as far as practicable in a condition for service. It is not apparent how this can be done without firing shotted guns."

It also seems important to me not to establish such precedents, lest the municipal authorities and the people at large come to regard such important military exercises as an unnecessary and unbearable encroachment on their rights. When the waters are clear it requires but a short time to fire the few rounds set apart for the annual instruction in artillery target practice, and no opportunity should be lost by our officers to cultivate a feeling of confidence in their skill to avoid accidents at all times, and to educate the people in this belief. Any other course will finally result in a total suspension of all firing, and consequently of the only exercise by which the efficiency of the artillery garrisons for war can be satisfactorily determined.

Blank Forms to insure uniformity of Observation and Record

The appropriate months for target practice having been designated, General Orders No. 12 of 1887 was issued prescribing the manner of conducting the practice and of making the requisite report. To facilitate this a number of blank forms were prepared and printed for distribution, but owing to unavoidable delays were not received at the several posts in time for general use. A copy of each form is submitted herewith, and I request that they may be forwarded to the War Department with the recommendation that they be included among the blank forms authorized by the Secretary of War. Their value will scarcely be appreciated in a small or one company post, but in a large command or at an extensive fortification they would be indispensable during active operations. Forms 1 to 6 were taken from the report made by Colonel J. Hamilton, 5th Artillery, of the target practice at Fort Hamilton, 1883. Forms 7, 8, 9, 10 and 11 were prepared at these headquarters.

Your attention is specially invited to Form No. 9 and the method adopted for obtaining the figure of merit. When the accuracy of the piece alone is in question this is usually done by aiming a number of shots at the centre of the target and finding their centre of impact. Each shot is then referred to this point as a new origin of co-ordinates from which its mean absolute deviation can be obtained. But while this method is applicable to the gun, and gives a mathematical measure of its accuracy, it is not a correct measure of gunnery which involves the skill of the gunner as well as the shooting qualities of the gun. Several ways of solving the problem have been discussed, but none of them appeared satisfactory. The error in lateral deviation of a gun is usually much less than the error of its deviation in range, and is therefore more under the control of the gunner. In other words, the gun is more surely handled in the horizontal than in the vertical plane, and therefore deviations in the two planes should not have the same value in determining marksmanship. The factor by which all lateral deviations should be multiplied in order to equalize these errors, is the ratio of the longer to the shorter side of the "probable rectangle" within which a certain per cent of the shots fired under precisely the same conditions would fall, and this is the method I recommend. As we have no data from which this factor can be obtained for the guns in service, I respectfully suggest that Lieutenant Whistler, 5th Artillery, be directed to embrace this subject in the experiments he is to conduct at Fort Wadsworth during the ensuing year to establish the curve of drift of the 8″ rifle, and that either at Fort Monroe or Fort Hamilton firing be conducted with the 15″ and 10″ guns for the same purpose.

Such in brief were the preliminary arrangements for the commencement of general and systematic artillery target practice by the batteries of the Division, those of the field artillery excepted.

THE TARGET PRACTICE OF 1887

Although it is quite impossible, without going at great length into details, to set forth all that anteceded the practice, and with which it was closely connected, the latter can be fairly appreciated by referring to General Orders No. 9, Headquarters Division of the Atlantic, 1888, and the copies of the target records accompanying it. While it was comparatively easy to prescribe what was to be done, the lack of means and the long interval during which there had been no firing rendered the execution of the orders far from easy, and except at one or two posts where annual target practice in some form had been the rule, the firing as well as the correct rendition of the required reports and plottings occupied several weeks beyond the time anticipated in the orders. Nevertheless, viewed as a whole, the result may be considered satisfactory, and not without much benefit. It has revealed in a striking manner the deficiencies in material now existing at all artillery posts, and at several the impracticability of having any kind of artillery target practice; it has illustrated in a marked degree the professional interest of a large number of the officers and enlisted men, and their ability to perform this hitherto much neglected duty intelligently, not only with the scanty means at hand, but to improvise such means where, as in some instances, they have been entirely wanting.

No two artillery posts of the Division are on equal terms respecting armament or the necessary facilities for target practice, the conditions ranging from comparative abundance at Fort Monroe, through Forts Hamilton and Wadsworth, where the facilities are less, to Fort Schuyler, where the plane-tables used were a make-shift, down to such posts as Newport Barracks, where target practice is out of question, not only for lack of matériel but because there are no ranges.

The question of equipment is of great importance, and it is earnestly hoped that a sufficient expenditure will be authorized from such appropriations as may be made for the purchase of artillery stores for the coming fiscal year, as will provide each garrisoned sea-coast fort where firing is practicable with suitable guns, plane-tables, anemometers, stop watches, etc., to the end that all the benefits possible may be derived from the annual target practice.

Some idea of what may be expected from careful and systematic firing and the use of even a few of the necessary instruments may be had by an inspection of the target record of battery "B", (Van Reed's) 5th Artillery. This battery has been stationed at Fort Wadsworth during the past six years, and has been so fortunate as to have practiced annually with heavy guns. The firing has been conducted with great care and the observance of prescribed rules, and the result is just what might have been expected.

It has the best figure of merit in the Division. It is respectfully suggested that a suitable prize be awarded battery "B", 5th Artillery, and hereafter to the battery making the best annual score, or that some other means be adopted to encourage a high degree of skill in gunnery. An equalization of the allowance of ammunition authorized in paragraph 469, Army regulations, per battery, is recommended, so that each may fire the same number of rounds. A single battery at a post has now an unquestioned advantage over batteries in larger commands.

THE FIELD ARTILLERY

There are four batteries of field artillery in this Division, and the record shows that they have had but little target practice, practice marches, or other instruction beyond the usual drills and garrison service. They, more than the foot batteries, need systematic target practice to render them efficient, because of the difference in equipment and the conditions under which their firing is conducted. The approaches to a fortification can be so thoroughly studied and marked that every shot can be fired deliberately under conditions of almost absolute certainty as to range, rate of movement of the object, and concentration of fire, and with comparative safety to those serving the guns. A field battery, on the contrary, is hurried into action, and usually fires at unknown distances, at objects more or less concealed, while at the same time it is exposed to a destructive fire on open ground.

The life of a field battery under such conditions will depend on its skill with the guns and no means should be considered too costly which will impress this fact upon officers and men, or lead to its attainment. No matter how a battery may excel in drill or appearance, if it lacks skill in gunnery it is but sounding brass or a tinkling cymbal when brought to the field of battle.

THE TARGET PRACTICE OF 1888

By referring to General Orders Nos. 10 and 14, current series, it will be observed that the instruction of the field batteries in target practice, as well as the foot batteries, is provided for, and if these orders are executed, as they no doubt will be, with the interest shown during the past year, the system of target practice thus happily inaugurated can no doubt be perfected and permanently maintained.

No precise measure of the importance of accurate artillery fire in time of peace can be given, but if estimated in terms of the probably short life of the modern high-power gun of large calibre, or by the great danger to which all harbors are exposed from the visits of hostile men-of-war, it is no doubt of such importance as to warrant the most strenuous efforts, and the inculcation of the feeling that we ought not to rest until we have devised and put in operation a perfect system of artillery defense for each harbor, and reached such skill with our guns as to make hitting the target the rule, and not as it is now, the exception; great and prosperous as is this country, it cannot afford to waste a single shot from a sea-coast gun in battle, lest by so doing we throw away what may prove to be our main protection against some redoubtable iron-clad.

Before closing I desire to invite attention to a kindred subject, viz.: the providing and perfecting of such appliances as are indispensable to the

LIST OF DESIGNS OF ARTILLERY MATERIAL RECEIVED AT HEADQUARTERS DIV. OF THE ATLANTIC, 1887.

OFFICER'S NAME.	DESIGN.	DISPOSITION.
Captain J. B. Campbell, 4th Art'y	System of Artillery plotting	Awaiting distribution and discussion.
Captain J. P. Sanger, 1st Art'y	Instructional target for artillery troops	Distributed for use.
Captain James Chester, 3d Art'y	System of artillery plotting	Awaiting distribution and discussion.
Captain James Chester, 3d Art'y	Method of laying out harbors	Awaiting distribution and discussion.
Captain G. G. Greenough, 4th Art'y	For plotting the center of a pintle	Awaiting distribution and discussion.
Capt. G. G. Greenough, 4th Art'y	Artillery system, consisting of protractor (telescopic with open sights), plotting table, table of fire, wind gauge and sliding vernier	Copy made and description printed and distributed to artillery posts for examination and report.
Captain E. L. Zalinski, 5th Art'y	Plane table and plotting board combined	Copy made and description printed and distributed to artillery posts for examination and report.
Lieut. E. T. C. Richmond, 2d Art'y	Drift of oblong projectiles	Awaiting distribution and discussion.
Lieut. G. N. Whistler, 5th Art'y	Artillery anemometor	Copies made and descriptions printed and distributed to artillery posts for examination and report.
Lieut. G. N. Whistler, 5th Art'y	Graphic tables of fire for 8"M.L. rifle	
Lieut. G. N. Whistler, 5th Art'y	Plotting table for sea-coast artillery	Awaiting distribution and discussion.
Lieut. G. N. Whistler, 5th Art'y	Design for breech sight and trunnion elevating arc	Copies made and descriptions printed and distributed to artillery posts for examination and report.
Lieut. E. T. Brown, 5th Art'y	Design for breech sight for siege and sea-coast guns	
Lieut. O. M. Lissak, 4th Art'y	Trestle for aiming mortars	Copy made and description printed and distributed to artillery posts for examination and report.
Lieut. S. M. Foote, 4th Art'y	Design for plotting board	Copies made and descriptions printed and distributed to artillery posts for examination and report.
Lieut. S. M. Foote, 4th Art'y	Scheme for mapping harbors	
Lieut. J. K. Cree and Lieut. G. O. Squier, 3d Art'y	Artillery anemometer	Copies made and descriptions printed and distributed to artillery posts for examination and report.
	Improved design of artillery anemometer	
Private Case, Bat. of Engineers	Wind gauge	Copy made and description printed and distributed to artillery posts for examination and report.

proper instruction of the personnel. Great interest has been shown by the artillery during the past year in this subject, and many valuable suggestions have been received. These have nearly all been reproduced in type and by the use of the hektograph or blue prints, and distributed to the various posts for discussion and report. It is understood to be the intention, as soon as the views of the artillery can be ascertained, to forward to the War Department such of the designs and suggestions as may appear to be useful.

The number and character of those already received are given in the accompanying table, which also shows what disposition has been made of them. (p. 141).

RECAPITULATION

To recapitulate briefly: a system of artillery defense for our seaports includes the mapping of the harbors, the establishment of suitable observing stations from which all approaches are plainly visible, the expert use in connection therewith of accurate range and position finders by which the location of objects can be quickly determined, and such perfect skill in gunnery as will insure a destructive and concentrated fire the moment the location of the object has been made known. The first step in the development of such a system has been taken during the past year, with what result I have endeavored to describe. The system of mapping the harbors already suggested, can be perfected it is believed, with no great difficulty, but the invention and advantageous employment of suitable range and position-finders, and the necessary skill with the guns to profit by them, can only be attained by the study and use of such instruments in their various forms, and by regular, systematic and painstaking service with the guns. And if the interest in these subjects already awakened be encouraged by suitable means, and such official recognition given as their importance justly demands, we may safely rely on our artillery to become adepts in the use of all cannon, and to elaborate a system of harbor defense adapted to the employment of modern armament and equal to any demands to which it may be subjected. If, on the other hand, artillery target practice is to be conducted in a haphazard way, without system or the appliances by which results can be immediately and accurately ascertained, all inducement towards the solution of this complex problem will be taken away, skill in gunnery will continue to be beyond the reach of even the most willing and capable, and we may expect to experience, in the course of time, the inevitable consequences of professional inferiority.

Very respectfully, your obedient servant,

J. P. SANGER,
Captain, 1st Artillery.

The report of the firing having been received, General Orders No. 9 were issued, establishing the figure of merit and publishing the results of the firing:

HEADQUARTERS DIVISION OF THE ATLANTIC,
GOVERNOR'S ISLAND, NEW YORK CITY.

GENERAL ORDERS
No. 9. April 12, 1888.

The figure of merit of the foot batteries of artillery in the Division, in artillery target practice, for the year 1887, is herein announced for general information.

Owing to a want of uniformity in the ranges and the number of shots fired by each battery, the figure of merit has been determined by taking the mean of the absolute deviations of all the shots fired during the season. If the several series of shots had all contained the same number of shots, and had they been fired at the prescribed distances, the figure of merit would have been determined as per Form No. 9, Artillery Target Practice.

The firing was replotted and the figures of merit computed from the plane table records of the batteries by Captain *J. P. Sanger*, 1st Regiment of Artillery, assisted by Lieutenant *A. D. Andrews*, 5th Regiment of Artillery.

BY COMMAND OF MAJOR GENERAL SCHOFIELD:

WILLIAM D. WHIPPLE,
Assistant Adjutant General.

Figure of Merit,
Artillery Target Practice, Division of the Atlantic
For the Year 1887.

POST.	Battery.	Date.	Gun.	Distance to target. (yards.)	No. of shots.	Mean Absolute Deviation.	Total Absolute Deviation of Series.	Figure of Merit.
Fort Preble, Me.	"M," 4th Artillery (Fuger's)	Oct. 18 and 19	15 in. S. B.	1730	12	82.1	985.6	
		Nov. 8	8 in. Rifle	2170	10	107.6	1076.2	
		Nov. 11	8 in. Rifle	2400	4	74.2	297.0	
		Totals ..	....	......	26	....	2358.8	90.7
Fort Warren, Mass	"H," 4th Artillery (Story's)	Nov. 17	15 in. S. B.	1365	2	224.6	449.1	
		Nov. 22	15 in. S. B.	2782	2	86.3	172.6	
		Dec. 7	15 in. S. B.	2115	2	98.0	196.1	
		Dec. 8	15 in. S. B.	2940	3	112.0	336.1	
		Nov. 17	8 in. Rifle	1235	3	102.6	307.8	
		Nov. 22	8 in. Rifle	2654	4	112.5	450.0	
		Dec. 1	8 in. Rifle	2230	2	64.3	128.6	
		Dec. 7	8 in. Rifle	1965	2	98.5	197.0	
		Dec. 8	8 in. Rifle	2788	4	52.2	208.9	
		Totals ..	....	......	24	....	2446.2	101.9
	"K," 4th Artillery Greenough's	Nov. 17	15 in. S. B.	1342	1	269.3	269.3	
		Nov. 22	15 in. S. B.	2784	3	137.2	411.5	
		Dec. 7	15 in. S. B.	2454	3	164.1	492.4	
		Dec. 8	15 in. S. B.	2890	2	194.9	389.9	
		Nov. 17	8 in. Rifle	1220	3	92.7	278.1	
		Nov. 22	8 in. Rifle	2660	4	119.4	477.3	
		Dec. 1	8 in. Rifle	2255	2	155.4	310.9	
		Dec. 7	8 in. Rifle	2326	2	224.6	449.2	
		Dec. 8	8 in. Rifle	2760	4	75.2	309.7	
		Totals ..	....	......	24	....	3388.3	141.2
Fort Schuyler, N. Y. H.	"K," 5th Artillery Brewerton's	Feb. 23	15 in. S. B.	1397	3	235.8	707.5	
		Feb. 23	15 in. S. B.	2438	1	60.5	60.5	
		Feb. 23	10 in. S. B.	1530	5	55.1	275.7	
		Totals ..	....	......	9	....	1043.7	115.9
	"M," 5th Artillery (Day's)	Feb. 23	15 in. S. B.	1405	3	116.8	350.4	
		Feb. 23	15 in. S. B.	2444	1	186.1	186.1	
		Feb. 23	10 in. S. B.	1530	5	95.8	478.9	
		Totals ..	....	......	9	....	1015.4	112.8
Fort Columbus N. Y. H.	"A," 5th Artillery (Beck's)	Nov. 22	15 in. S. B.	2505	4	106.5	425.9	
		Dec. 2	15 in. S. B.	2550	4	87.1	348.3	
		Nov. 21	8 in. Rifle	2510	8	182.5	1460.4	
		Dec. 2	8 in. Rifle	2624	2	124.8	249.7	
		Totals ..	....	......	18	....	2484.3	138.0
	"C," 5th Artillery (Morris')	Dec. 2	15 in. S. B.	2622	8	39.8	318.3	
		Nov. 17	8 in. Rifle	1690	3	121.7	365.1	
		Nov. 21	8 in. Rifle	2472	6	208.0	1248.1	
		Totals ..	....	......	17	....	1931.5	113.6
	"L," 5th Artillery (Randolph's)	Nov. 22	15 in. S. B.	2510	4	249.9	999.6	
		Dec. 23	15 in. S. B.	2580	4	224.1	906.4	
		Nov. 14	8 in. Rifle	1669	6	30.1	181.0	
		Nov. 16	8 in Rifle	2610	6	79.0	474.1	
		Totals ..	....	......	20	....	2561.1	128.1

POST.	BATTERY.	Date.	Gun.	Distance to target (yards.)	No. of shots.	Mean Absolute Deviation.	Total Absolute Deviation of Series.	Figure of Merit.
Fort Hamilton, N. Y. H.	**"E," 5th Artillery (Roemer's)**	Oct. 2	15 in. S. B.	2653	7	70.9	496.6	
		Oct. 10	8 in. Rifle	1370	1	20.6	20.6	
		Oct. 11	8 in. Rifle	2025	1	27.1	27.1	
		Nov. 17	8 in. Rifle	2535	10	58.6	585.9	
		Totals .	....	......	19	......	1130.2	59.5
	"H," 5th Artillery (Fessenden's)	Oct. 26	15 in. S. B.	2555	5	116.9	584.5	
		Oct. 19	15 in. S. B.	2515	1	15.1	15.1	
		Oct. 12	8 in. Rifle	1658	4	39.5	157.9	
		Oct. 26	8 in. Rifle	2555	4	51.8	207.3	
		Totals ..	....	......	14	......	964.8	68.9
	"I," 5th Artillery (Crabb's)	Oct. 11	15 in. S. B.	1962	2	459.5	919.1	
		Oct. 18	15 in. S B	2470	7	150.8	1055.6	
		Oct. 23	8 in. Rifle	2681	4	62.0	248.0	
		Totals ..	....	......	13	......	2222.7	170.9
Fort Wadsworth N. Y. H.	**"B," 5th Artillery (Van Reed's)**	Nov. 4	15 in. S. B.	1720	11	72.9	801.7	
		Oct. 20	8 in. Rifle	1676	7	49.3	344.9	
		Oct. 21	8 in. Rifle	1673	6	14.9	89.3	
		Oct. 28	8 in. Rifle	2487	8	70.6	564.6	
		Totals ..	....	......	32	......	1800.5	56.3

MISCELLANEOUS FIRING.

POST.	BATTERY.	Date.	Gun.	Distance to target. (yards.)	No. of shots.	Total Absolute Deviation.	Mean Absolute Deviation.
Fort Preble, Me..	**"M," 4th Artillery (Fuger's)**	Nov. 9	8 in. Rifle......	*	6	6290.6	1048.4
Fort Hamilton, N. Y. H.	**† "E," 5th Artillery (Roemer's)**	Nov. 2	8 in. Rifle......	3840	2	85.9	42.9
	† "I," 5th Artillery (Crabb's)	Nov. 2	8 in. Rifle......	3830	9	492.4	54.7
	† "H," 5th Artillery (Fessenden's)	Oct. 26	15 in. S. B.......	3878	2	117.3	58.6
		Oct. 26	8 in. Rifle......	3850	5	1168.0	233.6
Fort Wadsworth, N. Y. H.	**‡ "B," 5th Artillery (Van Reed's)**	Oct. 13	30 pdr. Parrott...	1520	12	1080.0	90.0
		Oct. 14 & Nov. 11	30 pdr. Parrott...	1540	11	333.0	30.3
		Oct. 14 & Nov. 11	4½ in. M. L. R...	1540	14	1266.2	90.4
Mount Vernon Barracks, Ala.	**"C," 2d Artillery (Hamilton's)**	1888 Feb. 24	3 in. M. L. R. ..	1187	11	1049.1	95.4
	"D," 2d Artillery (Scant'ing's)	Feb. 25	3 in. M. L. R....	1187	14	3005.5	214.7

* Target drifting mean distance 3837 yards.
† Range 1100 yards in excess of that prescribed in orders.
‡ Unauthorized.

POST.	BATTERY.	Date.	Gun.	Distance to target. (yards).	No. of shots.	Direct Hits.
Fort Barrancas. Fla.	"H," 2d Artillery (Grimes')	Sept.	3 in. M. L. R...... ..	1408	40}	3
			12 pdr. field gun......	1408	40}	
			in. siege mor.......	400	52	0
			4½ in. siege gun.....	2260	82	4
			4½ in. siege gun.....	2260	17	0
	"B," 2d Artillery (Grugan's)	Sept.	3 in. M. L. R........	1408	40}	1
			12 pdr. field gun......	1408	36}	
			8 in. siege mor.......	400	154	0
			4½ in. siege gun.....	2260	61	2

POSTS AT WHICH ARTILLERY PRACTICE TOOK PLACE, BUT FROM WHICH NO RECORD HAS BEEN RECEIVED.

Fort Monroe, Va.

POSTS AT WHICH NO ARTILLERY PRACTICE TOOK PLACE

At the following artillery posts no target practice took place during the year 1887:—

Fort Adams, R. I.
Fort Trumbull, Conn.
Fort Columbus, N. Y. H. (The garrison practiced at Forts Wadsworth and Hamilton.)
Fort McHenry, Md.
Washington Barracks, D. C.
Newport Barracks, Ky.
Little Rock Barracks, Ark.
St. Francis Barracks, Fla.

The garrison of Jackson Barracks, La., executed their firing conjointly with the militia of the States of Mississippi and Louisiana at Pass Christian, Miss. No record of the firing has been received.

ANOMALIES OF FIRING

As an illustration of the uncertainty attending the firing and the difficulty of making a good score the following data taken from the records is given:—

FORT PREBLE, ME.—Battery "M," 4th Artillery, with 15 inch smooth bore gun, October 15th, 1887.

Shot No. 4 had '27' greater elevation than No. 3, but had 79 yards less range. Shots No. 9 and 12 were fired with a difference of 2' in elevation, but gave a difference in range of 282 yards.

Same, with 8 inch rifle, November 9th, 1887. The target was found to be drifting. Six shots were fired with the following results:—

No. of Fire	Distance to Target. Yards.	Elevation	Shot Struck.	
			Short. Yards.	To the Right. Yards.
1	3570	6°	1100	50
2	3750	6° 50′	900	65
3	3800	7°	1220	135
4	3900	7° 30′	1190	180
5	3970	8°	1335	200
6	4030	8°	500	80

In this firing at a drifting target the mean lateral deviation was 118⅓ yards. The mean longitudinal deviation was 1040⅚ yards. The mean absolute deviation was 1048.4 yards.

FORT WARREN, MASS.—Battery "H," 4th Artillery, December 8th, 1887, with 8 inch rifle.

Shots No. 3 and 4 were fired with same elevation—6° 40′

No. 3 struck 18 yards short of target. No. 4 struck 102 yards beyond target, a variation in range of 120 yards.

Battery "K," 4th Artillery, with 8 inch rifle, November 22d, 1887, shots Nos. 3 and 4 were fired with same elevation, 6° 45′, but gave a difference in range of 360 yards.

FORT COLUMBUS, N. Y. H.—Battery "L," 5th Artillery, at Fort Hamilton, N. Y. H., with 15 inch smooth bore gun.

Shot No. 1, elevation 5° 45′, struck 42 yards beyond target.

Shot No. 2, elevation 5° 44′, struck 514 yards beyond target.

Shot No. 3, elevation 5° 40′, struck 400 yards beyond target.

Shots 2 and 3 explained by remark in Record of Artillery Practice for battery. The Zalinski sight was used, and was probably not properly adjusted in its seat.

In the firing of battery "L," 5th Artillery, Fort Wadsworth, N. Y. H., November 14th, 1887, with 8 inch rifle, a variation of 3′ in elevation gave a variation in range of 80 yards.

Same, at Fort Hamilton, December 23d, 1887, with 15 inch smooth bore gun, shots Nos. 2 and 4, same elevation—

No. 2 struck 480 yards short.

No. 4 struck 113 yards short.

Battery "A," 5th Artillery, at Fort Hamilton, N. Y. H., November 21st, 1887, with 8 inch rifle, shot No. 2, with 10′ *less* elevation than shot No. 3, struck at 105 yards greater range than No. 3.

Same, at Fort Hamilton, N. Y. H., December 2d, 1887, with 8 inch rifle, three shots out of a total of *five* tumbled.

Two of these projectiles were 'Eureka."

One of these projectiles a "Butler."

Powder charge, 25 pounds, Hexagonal.

Same, at Fort Hamilton, N. Y. H., December 2d, 1887, with 15 inch smooth bore gun, shot No. 2 had 23′ *greater* elevation than No. 1, but struck at a range of 58 yards *less* than No. 1.

Battery "C", 5th Artillery, at Fort Wadsworth, N. Y. H., November 17th, 1887.

Seven shots fired. Of these four tumbled.

Powder, Hexagonal; charge, 25 pounds.

Projectile, "Butler."

Same, November 21st, 1887. Shots Nos. 1 and 5 struck five yards apart. Difference in elevation was 45′.

FORT HAMILTON, N. Y. H.—Battery "H", 5th Artillery, October 26th, 1887, with 8 inch rifle. Shots 1 and 3 were fired with same elevation, 6° 15′, but gave a variation in range of 440 yards.

Battery "E," 5th Artillery, with 8 inch rifle, October 17th, 1887. A variation of 1′ in elevation in shots 3 and 4 gave a variation in range of 177 yards.

In the firing October 24th, 1887, with 15 inch smooth bore gun, shot No. 2, with 6° elevation, struck 87 yards beyond target. Shot No. 3, with 10′ *less* elevation, struck 142 yards beyond target, or at 55 yards greater range.

Battery "I," 5th Artillery, October 18th, 1887, with 15 inch smooth bore gun. Shot No. 3, with 20′ *less* elevation than shot No. 2, struck at a range 80 yards greater,

Same day a variation of 1′ in elevation between shots 5 and 6 gave a longitudinal variation of 195 yards.

FORT WADSWORTH, N. Y. H.—Battery "B", 5th Artillery October 20th, 1887, with 8 inch rifle. Shots Nos. 2 and 3, each at 4° 0′ elevation.

No. 2 struck 22 yards short.

No. 3 struck 104 yards beyond.

An extreme variation of 126 yards.

Same, October 13th, 1887, with 30 pounder Parrott rifle, (Gun No. 305). Shot No. 2 had 22′ less elevation than No. 1, but struck at an increased range of 54 yards, or 240 yards over target.

With 30 pounder Parrott rifle (Gun No. 302). Shot No. 2, elevation 2° 25′, struck 200 yards short.

Shot No. 3, same elevation, struck 20 yards short.

No doubt some of the above anomalies are the result of carelessness in loading and pointing the piece. The space occupied by the charge and projectile, and the distance of the eye of the gunner from the rear sight, in aiming, should be uniformly the same. The officer in charge should give these points his special attention. The height of the gun above the water is also to be considered in all cases, and the theoretical tables of ranges should be modified so as to allow therefor. This does not appear to have been done in all cases during the recent practice.

All of the old breach sights should be verified before being used, as also the position of the index of the fulcrum stand with reference to the zero point on the elevating arc.

ARTILLERY MATERIAL

The following is an abstract of the reports made by the officers and non-commissioned officers of the several foot batteries, under section 4, paragraph IV., General Orders No. 12, Division of the Atlantic, 1887, of the artillery material used during the target practice.

FORT PREBLE, ME.—Battery "M," 4th Artillery.

15-*inch S. B. M. L. Gun.*

1. Powder of inferior quality. 2. Pintle key came out after second shot. 3. Floor boards of chassis broken. 4. Wheels of top carriage would not remain in gear, requiring for that purpose the use of hand-spikes. 5. Chassis, no steps or hand-spike hooks.

8-*inch M. L. Rifle.*

1. Platform and traverse circle out of level, causing guides of top carriage to bind and the use of pinch bars necessary to move it. 2. Retraction gear out of order; four ropes broken in moving top carriage. 3. Hydraulic cylinder leaky. 4. One projectile stripped.

FORT WARREN, MASS.—Batteries "H" and "K", 4th Artillery.

15-*inch S. B. M. L. Gun.*

1. After first round the retaining pawl jammed in the teeth of the chassis rack, and a block and tackle were necessary to release it. At second round the teeth of chassis rack were broken. This accident was probably caused by there not being sufficient liquid in the hydraulic recoil cylinder.

8-*inch M. L. Rifle.*

1. Shell hooks unserviceable. 2. No crane or pulley for hoisting projectiles. 3. Difficulty and danger to gunner in dismounting from chassis after sighting, owing to faulty position of chassis steps. 4. Retraction gear imperfect, involving unnecessary labor. 5. Bolt of front shoe broken. 6. Front and rear wheels of top carriage did not revolve, at times requiring the use of pinch bars. 7. Rear transom bolt broken. 8. Retraction ropes broken.

FORT SCHUYLER, N. Y. H.—Batteries "K" and "M," 5th Artillery.

15-*inch S. B. M. L. Gun.*

1. Carriage without recoil cylinder or friction plates. 2. Pintle plate and pintle bent; rear traverse wheels do not bear. 3. Guides of top carriage strike the front and middle transoms of chassis, and need cutting.

10-*inch S. B. M. L. Gun.*

1. Elevations as shown by quadrant and by index on fulcrum stand disagree by 15′ of arc. Improvised plane tables were used in locating the shots.

FORT COLUMBUS, N. Y. H.—Batteries "A," "C," and "L," 5th Artillery. Target practice at Forts Hamilton and Wadsworth.

15-*inch S. B. M. L. Gun. Fort Hamilton.*

Battery "A" reports: 1. Bore foul. 2. Sponge unserviceable.

Battery "C" reports: 1. Sponge unserviceable.

Battery "L" reports: 1. Left front guide bears against chassis rail; pinch bars necessary to move carriage. 2. One bolt sprung in front buffer. 3. Retaining pawl lever worked with difficulty.

8-inch M. L. Rifle. Fort Hamilton.

Battery "A" reports: 1. Sponge unserviceable. 2. Bore very foul.

Battery "C" concurs.

8-inch M. L. Rifle. Fort Wadsworth.

Battery "C" reports: 1. No crane on carriage; projectile raised by improvised shears.

Battery "L" reports: 1. Bore foul from previous firing. 2. Front wheels of top carriage failed to bear. 3. Drum of retraction gear not large enough. 4. Pinch bars necessary to move top carriage into battery. Cause not stated.

During the firing a large number of the Butler projectiles tumbled, supposed to be the result of using but 25 pounds of powder. It was thought the carriage would not stand the full charge of 35 pounds.

Captain *W. F. Randolph*, 5th Artillery, commanding, reports that he used the graphic method and anemometer of Lieutenant *Whistler* with excellent results. He calls attention to the differences in recoil between 8-inch rifled guns mounted on similar carriages and using same charge at Forts Hamilton and Wadsworth. At Wadsworth the gun recoiled to the counter buffers and returned partially into battery; at Hamilton it did not recoil as far as the buffers. Probably the hydraulic cylinders at Wadsworth did not contain enough liquid and those at Hamilton too much.

FORT HAMILTON, N. Y. H.—Batteries "E", "H," and "I," 5th Artillery

15-inch S. B. M. L. Gun.

No adverse report of the gun or carriage received.

8-inch M. L. Rifle Gun.

1. Bolt broken. 2. After the fifth shot of battery "H," bolt on left front fork broken, and also bolt of left front guide. 3. After seventh shot by battery "E", floor boards broken, and after ninth shot bolts and right guides of one carriage broken, and after tenth shot right guide and bolt of another carriage broken.

FORT WADSWORTH, N. Y. H.—Battery "B," 5th Artillery.

The officers and non-commissioned officers made no reports as directed in general orders.

Lieutenant-Colonel *H. W. Closson*, 5th Artillery, reports as follows: "The present crippled condition of the ordnance department rendered it impossible to fill requisitions for much that was needed, and the engineer department for lack of funds were not able to undertake any repairs or additions to the batteries and gun beds.

"The guns themselves, their carriages, the powder, the primers, the projectiles, and the sights are in great measure antiquated or obsolete, but these defects so far as possible were remedied by the energy and ingenuity of the officers of battery "B," aided by all that the department could give us. A man can be taught his exercise very well with a flint-lock musket, and with a sea-coast gun of only half the length it ought to have, he can learn a great deal that may be usefully applied when he is better provided. The results obtained in the practice are offered for no more than they are worth, as securing some familiarity with the armament and material we now have, and as indicating a direction in which to proceed when we get better, and it is to be distinctly understood that the deficit is out of our power to remedy.

"I do not undertake to give in detail what is required, as it is evident enough to all concerned, and amounts to saying that we have almost nothing and used almost everything. * * * *

"Lieutenant *Whistler* used a trunnion quadrant of his own arrangement as well as a sight of his own in getting elevation and direction, both improvements upon the old regulation models.

"Lieutenant *Brown* complemented the ordnance sight with a device of his own for securing greater accuracy, and as ordnance officer carefully attended to weighing projectile and charge.

"There are but two carriages for the 8-inch rifle (barbette), and, as will be seen, the charge was but 25 pounds of powder; with an additional supply of the carriages now difficult to procure, it might be increased to the full service amount—35 pounds."

The report of Artillery Material rendered by 1st Sergeant *Charles R. Thornhill*, battery "M," 4th Artillery, is specially commended for its completeness.

RECOMMENDATIONS RECEIVED CONCERNING MATERIAL

The following recommendations are considered worthy of notice:—

By Captain *G. G. Greenough*, 4th Artillery. 1. That a breech sight made wholly of bright metal is not suitable for all eyes, and that darkened sights, more open and sliding in a wider slot would be of advantage. That the peep sight is too small and should be provided with cross hairs. 2. That the position and form of the steps of chassis should be changed so as to facilitate dismounting therefrom. 3. That a change in the form of the drum of retraction gear to correspond with new 15-inch carriages, and the substitution of wire for hemp rope be made.

By Corporal *T. G. Stoner*, battery "L," 5th Artillery. 1. That the size of the teeth in the circular toothed arc be diminished, so that the correct elevation can be more readily given. 2. That the top-carriage of the 15-inch gun be provided with similar elevating apparatus.

All circumstances considered, the result of this, the first attempt at general artillery target practice in this Division, may be considered quite satisfactory. It is desirable that more attention be given details, and that no effort be spared to insure a full compliance with the orders that have been or may be issued respecting this important branch of artillery instruction.

In this connection attention is invited to the following remarks from the report of Lieutenant-Colonel *Closson*, 5th Artillery, on the target practice at Fort Wadsworth, which views are concurred in by the Commanding General:—

* * * * * * *

"It is not desirable that each gun be fired by a council of war, so that elevation and direction become a compromise of conflicting opinions. On the contrary, every officer in turn should himself control his own guns, and be enabled to claim the entire credit of success or receive the whole responsibility of failure.

"He can secure the desired knowledge in no quicker way.

"He should not always feel absolutely helpless if not guided by the assertion of some expert, or unless he has a whole laboratory of apparatus at his back.

"The latter has a secondary usefulness in training the judgement, and especially in furnishing a continually increasing amount of data from which tables can be made and revised that will give a generally correct initiative.

"And in the ordinary leisure of target practice he can well afford to avail himself of any means for estimating atmospheric changes, and he who makes a corresponding allowance will do better than he who makes none, and however imperfect our present indices of value may be, they will lead to good habits in more prosperous times.

"No care can be too minute for securing thorough uniformity and accuracy in the preparation and handling of cartridge, projectile, and gun. No infantry man would think of using ammunition that was fouled with dirt and deformed with bruises; the artillery man should manipulate his ammunition as carefully, and see that it is clean.

"The same air space in rear of the projectile should be maintained by rings accurately marked on the rammer, and by stripping the choke of the cartridge of all superfluous length.

"The elevation of the gun should be nicely verified the last thing before firing, as the element of accuracy most difficult and most necessary to obtain, and in examining the platform, carriage, etc., afterward, care should be especially taken to see that the vent is perfectly free before re-loading, or else the charge may have to be drawn with much trouble and some danger.

"The elevation should not be hastily and continually varied for consecutive shots, but before change the mean result of at least two secured and noted as an index of the alteration required.

"All this is elementary enough, no doubt, but it grows out of what has been actually seen and done here, and would probably be repeated elsewhere.

"Either extreme is to be avoided, whether the heedless omission of all minor detail in the perfunctory discharge of what gets to be looked upon as mere routine, or the needless delay for a favorable combination of scientific subtilities from all quarters." * * * *

HEADQUARTERS DIVISION OF THE ATLANTIC,

GOVERNOR'S ISLAND, NEW YORK CITY.

GENERAL ORDERS
No. 10. April 13, 1888.

Artillery target practice as prescribed in general orders Nos. 11 and 12 of 1887, from these headquarters, and further directed herein, will be conducted this year as follows:—

I. FOOT BATTERIES TO PRACTICE WITH 8" RIFLES AND 10" MORTARS, SIEGE OR SEA-COAST.

Fort Preble, from October 15th to November 15.
Fort Warren, from October 1st to 31st.
Fort Adams, from October 1st to 31st.

Fort Trumbull, from December 1st to December 31st.

Fort Schuyler, from December 1st to December 31st.

Fort Columbus, from October 1st to November 30th, at Forts Hamilton and Wadsworth.

Fort Hamilton, from October 1st to 31st.

Fort Wadsworth, from November 1st to 30th.

Fort McHenry, with mortars in May; with 8″ rifles either at Fort Carroll or Fort Monroe, as may be hereafter directed.

Washington Barracks, at Fort Monroe, Va., as may be hereafter directed.

Fort Monroe, as prescribed in the regulations of Artillery School.

Foot Batteries to Practice with 4½″ Siege Guns and 10″ Mortars.

Fort Barrancas, from November 1st to November 30th.

Foot Batteries to Practice with Field Guns

St. Francis Barracks, November 1st to 30th.

Mount Vernon Barracks, November 1st to 30th.

Jackson Barracks, from November 1st to 30th.

If vertical targets be used with field or siege guns they will be 10′ in height and 20′ wide. Solid shot, blind, or percussion shell will be used only.

Should it be found impracticable for any cause to finish the target practice in the time designated, it will be continued with as little delay as possible by each post commander until completed.

The regulation allowance of ammunition will be equally divided between guns and mortars, one-half of the shots being fired at each range. When land ranges are not available the firing of mortars will be directed towards the adjoining waters. The mortar targets will be placed at 1000 and 2000 yards. Those for sea-coast and siege guns at 1700 and 2700 yards. Those for rifled field guns at 1200 and 2500 yards.

The foregoing distances will not be changed except by authority from these headquarters, and care will be taken to locate the targets so as to conform thereto. This can be done in the case of floating targets by suitable range stakes on shore, by buoys, and the use of the plane-tables.

The ground about land targets, for a distance of 200 yards, will be staked off in such manner as to facilitate the accurate and rapid marking of the points of impact. The vertical targets of field guns will be divided into squares, for a similar purpose.

The proper preliminary instruction having been given, it is directed that the firing be so conducted that each non-commissioned officer of a battery shall fire a pro rata number of the rounds furnished. Full service charges will be used with all guns mounted on carriages with hydraulic or pneumatic cylinders, and the rammer staves will be marked so as to insure a uniform position for the cartridge and projectile.

No officer or enlisted man will be excused from the practice of his battery, except for reasons of which the post commander will judge, and these in all cases should be of such importance as to render such absence necessary.

It is expected that the practice will be exclusively *by battery*, and that the entire record and plottings will be complete and separate for each battery. Plane-table observers and markers will be taken from other batteries when practicable, so that all officers and enlisted men of a battery will be at the guns during the practice.

From the records received of the target practice of the past year, it is apparent that some carelessness prevailed in the execution of the orders from these headquarters. There should be no recurrence of this, or any failure to carry out such orders implicitly and promptly.

II. To this end the following explanation of the orders heretofore issued, which do not appear to be understood in all cases, will be noted:—

Par. IV., G. O. No. 11, 1887.—Captain *G. G. Greenough*, 4th Artillery, having devised a method for determining automatically the distance and direction from any gun to each square into which harbor charts are divided, the tables required by the last section of this paragraph are not necessary.

Par. VIII., G. O. 11, 1887.—In executing the provisions of this paragraph it is suggested that the following method be observed in teaching the use of sights:—

A machine gun and a short range instructional target constructed as follows will be used:—

At 30 yards or less from the gun, a vertical screen of cloth, paper or wood will be placed, on which will first be marked the projection of the axis of the gun x when the piece is horizontal. This point having been accurately determined, the tangent scale will be set for 200, 300, 400, 500, 800 and 1000 yards successively, and a shot fired at each elevation. From these will be determined the vertical distances above z where the trajectories for the different ranges intersect the screen. The zero point z and the points of intersection will then be transferred to a target of sufficient height, the ranges corresponding to the elevations being indicated in the margin, all as shown in the accompanying figure.

A *deviation* target can be similarly constructed for the 45 calibre Gatling gun, which has no drift sight, by using the data under "Drift," Table of Fire No. 1, Appendix D, Manual of Rifle Firing. The distances therein given should be laid off on a horizontal line from the zero point to the left. By making the target 8′ high and 5′ wide it will receive shots fired with the elevation and deviation for all distances between 100 and 1000 yards.

To use the target set it up at 30 yards from the gun, adjust the sight for any distance, say 500 yards, aim at the zero point z, and fire one shot; it should hit the centre of the 500 yard square.

It is important to notice at what distance from the rear sight, both sights and the object to be aimed at can best be focussed by each non-commissioned officer, and to caution him to always observe that distance in aiming. For many men this distance is about one foot in rear of the sight.

The non-commissioned officers, and subsequently such privates as are capable, will be assembled and instructed, first in giving the *direction*, secondly in giving the *elevation*, thirdly in giving *direction*, and *elevation*. About two weeks will be devoted to the foregoing exercises.

As soon as the use of the sights has been learned, single shots will be fired with the gun, using the instructional target, and the result noted. The instructor will be careful to explain the meaning of fine and coarse sights, the value of sight graduations and the meaning of "points" as applied to the deviation scales.

Par. XI., G. O. 11, 1887.—Except in one instance this requirement was not observed. If proper daily records of the firing are kept there would seem to be no reason why the reports of the practice should not be completed in the time designated.

Sec. 1, *Par. IV., G. O.* 12, 1887.—The battery commander will superintend *in person* all the details of the practice of his battery, and will prepare the reports. Either he or his officers will make the plotting of the shots, which with the other records will pertain solely to his own battery. In some instances during the past year the reports and plottings of batteries were consolidated.

Sec. 3, *Par. IV., G. O.* 12, 1887.—As much difficulty has been experienced in procuring the target therein prescribed, it is ordered that floating targets, made to correspond with Figures 3, 4, Plate 15, "Manual of Heavy Artillery Practice," be used.

Sec. 4, *Par. IV., G. O.* 12, 1887.—The report designated will be rendered to the battery commander on *Form* 10 when the entire practice of the year is completed, and will contain all observations on the material used during the practice. Such defects as become apparent from day to day should be reported, and rectified, if possible, by the post commander. A note book of convenient size will enable each officer and non-commissioned officer to prepare the report without difficulty.

Sec. 8, *Par. IV., G. O.* 12, 1887.—The "Figure of merit" will be calculated as prescribed in *Form No.* 9 recently issued from these headquarters, and to which reference is made in this order. The name of the gunner sighting whenever the target is hit will be reported in the column of remarks.

Par. VI., G. O. 12, 1887.—The plotting sheet will coincide with that portion of the harbor chart covering the position of the targets and ranges, and will be ruled in corresponding squares. The plottings will be made from the data on *Form No.* 7, and the shots will be numbered in series to correspond with the numbers on the plane table record. There will be a separate plotting sheet for each calibre of piece and prescribed range.

EXPLANATION OF ARTILLERY TARGET PRACTICE FORMS

III. The "blank forms of Artillery Target Practice," issued from these headquarters, will be used as herein modified, at all artillery posts where target practice may be had. If there be an insufficient number of blanks, the deficiency will be supplied by ruling additional forms.

Attention is invited to the following explanation of the forms for target practice.

All the forms should be signed by the officer using them.

Forms 1, 2, 3, 4 will be approved by the commanding officer before being acted on by the adjutant. These four forms need no explanation; they are in the nature of memoranda for the adjutant, on which the necessary orders are issued by the commanding officer, and it is believed will be specially useful in a large garrison.

Form No. 5.—This will be used at the guns, and each column will be filled under the direction of the officer in charge. It is of importance that the "deflection allowance" and "apparent deviation" be noted after each shot; when a transit is available the "apparent deviation" can be accurately determined, when no instrument, improvised or otherwise, is available at the gun, the "apparent deviation" will be carefully estimated by the eye, and the result stated. After each shot the officers and non-commissioned officers will be required to note down the deviation as it appears to them, the true deviation as subsequently measured will be entered beside these estimates, which are handed to the battery commander at the close of the firing each day.

Form No. 6.—The last sentence under "Remarks" is superfluous.

Form No. 7—This record is made for each series of shots for each calibre, and at each separate range, The number of fire will correspond with the number of the shot on the plotting sheet. The first entries under columns Angle A, Angle B, will be the target angles; the second, the gun angles. These will not be numbered and will be followed by the angles of the shots fired. The target angles of floating targets will be verified from time to time, and if the target shifts its position the mean of the several readings of the various positions will be assumed and noted on the form at the conclusion of the firing as the mean position of the target. The column headed "Deviation" on this form is superfluous, and need not be filled.

Form No. 8.—This will not be known as a "target practice form," but as "Report of Tracking Vessel Exercise."

Forms No. 9 *and* 11 will be consolidated in one to replace *Form No.* 8, and will include without repetition, all the data on both forms referring to wind and the condition of the atmosphere. The other data on these forms will be omitted.

Form No. 9.—For this form will be substituted the method of obtaining the mean absolute deviation and "figure of merit" as recently issued from these headquarters.

Form No. 12.—For this form the English Morse Signal Code, published in general orders No. 12, Headquarters of the Army, 1886, will be substituted.

Form No. 14 will be known as *Form No.* 11, and will be modified as follows: column No. of Gun and those under "Deviation" omitted, as well as the note on lower margin.

The order regulating the target practice of the field batteries will be issued in due season.

By command of Major General Schofield:

WILLIAM D. WHIPPLE,
Assistant Adjutant General.

With the publication of this order my connection with the subject of artillery target practice ended.

The death of General Sheridan in 1888 was followed by the removal of General Schofield to Washington as his successor in command of the army.

On December 7, he issued G. O. No. 108, to which reference is made by Captain Morse, and which, with the exception of the provision for divisional inspectors of artillery, was an exact copy of the orders issued in the Division of the Atlantic in 1887. The square system therein established was thus extended to the whole army, and was continued until 1893, when, on the suggestion of Captain (now Colonel) H. L. Harris, 1st Artillery, certain changes were made.

Having some curiosity to learn what they were, I wrote him about a year ago, and received in reply a long and interesting letter, from which I quote the following:

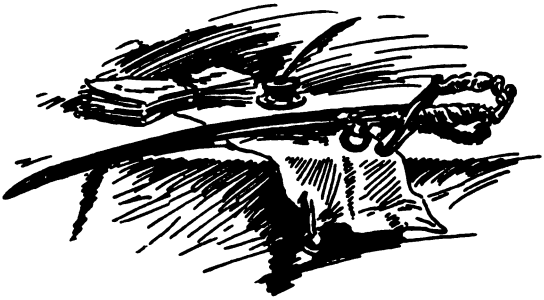
"The method of squares was the only method then (1887) of indicating to the commander of a sea-coast battery even the approximate position of the target at which he was to fire, or rather the comparatively small area in which his target was situated. The indication (as to the squares) was available for one or all of the guns of the fort no matter where situated, for each gun commander (sic) had only to turn to the tables computed for his gun in order to obtain the range and azimuth of the center of the square in which the target was situated.

"The method was principally useful for indicating the location of a fixed target, for in the case of a moving target a prediction for a subsequent position was liable to be considerably out, since the observing intervals were far apart, and the means of communication slow.

"Whatever its disadvantages, the method of squares was, at the time of its adoption, the *only* method available, and it answered the purpose of target practice fairly well. The guns then mounted were of very limited range, and the computed tables of the square centers in the field of fire, tho 'cumbersome', were not *impracticable*. There was plenty of time to consult this table between shots, if necessary, for the captains of that day sometimes occupied thirty minutes or more in *verifying* the sight.

"This method gave the artillery something to *do*, and still better, something to *think about*. It aroused the ambition of many officers, especially those who had been set to work to compute the various 'tables of squares' and to draw the maps on which the squares were to be laid off, to get something better, as they saw that with the increased range of the guns that were projected, that it was necessary to provide for a more accurate way of predicting for a moving target; that each group of guns must have its own position finder; and that the method must be simplified to admit of fire control. So, little by little, improvements were made, instruments of precision for locating the target were devised, as were methods of conversion into corrected range and azimuth, yet, since the method of squares was a *method of polar co-ordinates* applied to the square centers, it was only necessary to reduce the squares to points, and strip the method of its multiplicity of calculations and the now impracticable tables, and lo—the method introduced by Captain Sanger is still with us, in a greatly modified form.

"This, then, is the answer to the query—we never did change—we simply modified."



A Field Ballistic Problem

By Major Meade Wildrick, C. A. N. A., U. S. Army

The following is a solution to the "Field Ballistic Problem" as given in the January-April, 1918, issue of the JOURNAL U. S. ARTILLERY. The problem was originally based on "Notes on Ballistics" by Colonel Alston Hamilton, C. A. C., and Major George A. Wildrick N. A. (C. A. C.) The problem may also be solved by referring to "Gunnery for Heavy Artillery" as indicated in the following pages.

It is hoped that this problem may be of assistance in illustrating the practical value of ballistics in the field. Having in your possession the range table of a particular gun, it will be a comparatively simple problem to compute correction charts for use with the above gun for land firing. In addition, with our Railroad Coast Artillery guns, it will be necessary to develop new Range Correction Charts which will correct for variable heights of site, to take the place of the tide curve on the Pratt Range Correction Board and the permanent height of site corrections as now applied on the range-drum by means of the Elevation Table.

To illustrate how the above problem can be handled let us assume the following hypothetical problem.

ASSUMPTION:

You are assigned as Battery Commander to a battery of captured German guns. The Range Scales have been destroyed; in addition you are given a quantity of captured shells and powder charges for this particular gun.

Caliber 12-inch (railroad mount) gun, rifled right.
Projectile—Weight 1070 lbs; Radius of Ogive 7 calibers.
Weight of powder charge, including igniter 334 lbs.

You are ordered to prepare data necessary for use of these guns.

PART I.

CONSTRUCTION OF RANGE TABLE.

STEPS TO BE TAKEN:

(a) Fire a series of shots with captured ammunition through Chronograph Screens—Assume the M. V. thus determined to be 2250 f. s. Knowing the M. V. obtained, the angle of departure φ, the Range of the shots R, by correcting back to normal conditions of height of site, atmosphere, and wind, the value of the Ballistic Coefficient for the particular projectile can be determined. (G. H. A., p. 42.)

In case no Chronograph Screen is available the approximate M. V. developed by the powder can be determined by firing a series of trial shots with a certain value of φ. Measure carefully the range of the shots "R", and correct back to normal conditions of height of site, atmosphere and wind. Assuming C as known, as in (b) following, an approximate value of M. V. can be obtained from Table II.

(b) Determine Ballistic Coefficient of projectile—Assume

i = .63 for 7 cal., (N. B., p. 12 and G. H. A., p. 46.)

$$C = \frac{w}{id^2} = \frac{1070}{.63 \cdot 144} = 11.7945+.$$

$$\log C = 1.07167$$

(c) Compute a line of the Range Table for 5000, 10,000 and 15,000 yards, using table B and Table II. Tabulate results. (N. B., pp. 27-28 and G. H. A., p. 55.)

Function	Formula	5000	10,000	15,000
Angle of Departure, φ	$\sin 2\varphi = AC$	3°3′	6°54.8′	11°59.8′
Time of flight, T	$T = \frac{CT'}{\cos \varphi}$	7.24 sec.	15.87 sec.	26.40 sec.
Maximum Ordinate, Y_0	$Y_0 = 4.05T^2$	210.7 ft.	1013 ft.	2801.5 ft.
Angle of Fall, ω	$\tan \omega = B' \tan \varphi$	3°23.6′	8°34.5′	16°27.2′
Slope of fall.	$\tan \omega = \frac{1}{x}$	$\frac{1}{16.86}$	$\frac{1}{6.63}$	$\frac{1}{3.39}$
Remaining velocity, V_ω	$V_\omega = \frac{u \cos \varphi}{\cos \omega}$	1916.6 f.s.	1629.3 f.s.	1403 f.s.
Perforation of concrete.	$P_c = \frac{.0011475 wV_\omega}{3r^2}$	21.8 ft.	18.5 ft.	15.9 ft.
Perforation of sand.	$P_s = \frac{.0011475 wV_\omega}{r^2}$	65.4 ft.	55.5 ft.	47.7 ft.
Deflection 10 mile wind.	$d = \frac{W_y Z}{V} \cdot D_w°$	.032°	.068°	.111°
Drift.	$D = (1-K) \frac{d^2}{wn} (\varphi+\omega) \sec \varphi$	.104°	.252°	.470°

(d) Graudate the Range Scales.

This can be done by computing the value of φ for every 200 yds. of range as in Part I (c) above. Then by means of a clinometer graduate the range scale. Interpolate between the 200 yard divisions. (G. H. A., p. 64.)

PART II.

CONSTRUCTION OF RANGE CORRECTION CURVES.

Note.—The range table values found in Part I of this problem were computed under the following five main assumptions. (G. H. A., p. 63.):

(a) That gun and target are on the same plane, and that the earth is flat.

(b) That the atmospheric density is normal, i. e., thermometer 15° C, barometer 750 mm, saturation 78 per cent.

(c) That there is no wind.

(d) That the muzzle velocity developed by the powder is standard, i. e. 2250 ft. seconds.

(e) That the form and weight of the projectile are standard, i. e. wt. = 1070 lbs., d = 12″, n = 7 cal.

Now in the field the above five assumptions upon which the Range Table has been computed and the range scale has been graduated will not hold true, but will change continually. We must, therefore, compute a set of correction curves (similar to the Pratt Range Correction Board), which will correct for deviations from the first four of the above assumptions. To avoid the use of plus and minus corrections, let us assume the following normal reference numbers: Height of Site 400, Atmosphere 16, Wind 50, Muzzle velocity 2250 f.s.

Correction Curves

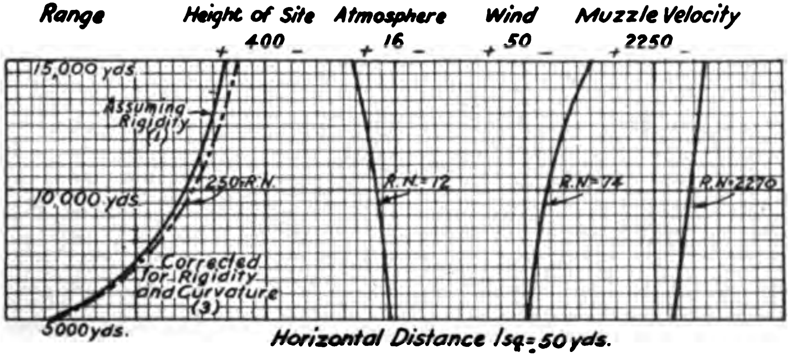


Fig. 1.

2172

(a) CORRECTION FOR THE FIRST PART OF THE FIRST RANGE TABLE ASSUMPTION.

(1) That the gun and target are on the same plane.

Compute points on the correction curve for ranges of 5000, 10,000, and 15,000 yards, when the gun is 150 ft. below the target. Reference number: 400 − 150 = 250. (See Chapter VIII, G. H. A.)

Method.—Assuming the theory of the rigidity of the trajectory.

φ = Range Table Value for Range R.

$$\text{Tan } \varepsilon = \frac{150}{3\,R}$$

therefore,

$\varphi_1 = \varphi \pm \varepsilon$ (Depending on relation of gun and target).

From Range Table (part 1) find range R corresponding to φ.

From Range Table (part 1) find range R_1 corresponding to φ_1.

Therefore, *Range Correction* $= R_1 - R$.

(Plot this point on the height of site correction curve below).

Height of Site Correction
(assuming rigidity)

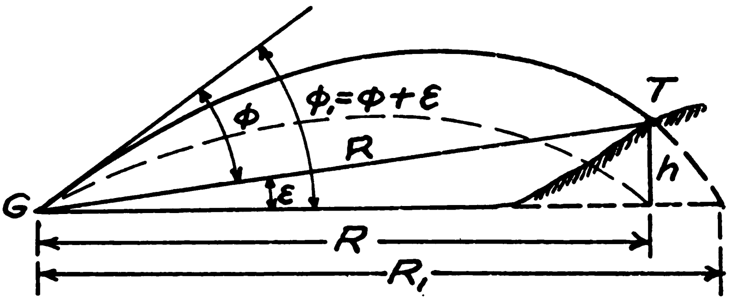


FIG. 2. 1178

Formula used when no range table is available:

$$\text{Sin } 2\,\varphi_1 = AC \text{ or } A = \frac{\text{Sin } 2\varphi_1}{C}$$

From Table II, find corresponding value of Z for A and V.

$$\text{Now, } Z = \frac{X_1}{C} \text{ or } X_1 = CZ$$

Range correction $= X_1 - X$. Plot this point, (See Fig. 1).

Solution—Height of Site (Assuming Rigidity).

Function	Formula	5000	10,000	15,000
Angle of site ε	$\tan \varepsilon = \frac{h}{3R}$	34.4′	17.2′	11.5′
Q. A. D.	$\varphi_1 = \varphi \pm \varepsilon$	3°37.4′	7°12.0′	12°11.3′
A	$A = \frac{\sin 2\varphi_1}{C}$	.010695	.021086	.034995
Z	Table II.	1482.1	2626.3	3856.7
X_1 (Range in ft.)	$X_1 = CZ$	17,480 ft.	30,975 ft.	45,487 ft.
Range correction	$R_1 - R$	+827 yds.	+325 yds.	+162 yds.

(2) In the above solution we assumed the Theory of the Rigidity of the Trajectory. This Theory we know is not true and is corrected for by the French in what they term "The Complimentary Angle of Site." The error in the Theory of the Rigidity of the Trajectory can be shown graphically as follows:

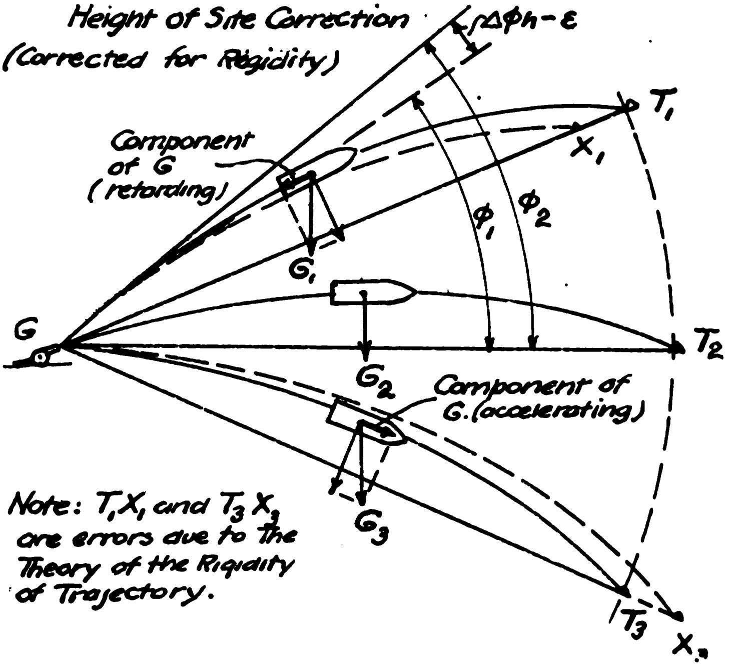

Height of Site Correction
(Corrected for Rigidity)
$\angle \rho \Delta \phi h - \varepsilon$
T_1
X_1
Component of G (retarding)
ϕ_1
ϕ_2
G_1
G
T_2
G_2
Component of G. (accelerating)
G_3
Note: T_1X_1 and T_3X_3 are errors due to the Theory of the Rigidity of Trajectory.
T_3
X_3
2174

FIG. 3.

From the above Figure it can be seen that when the target is above the gun the projectile will fall short of the target due to the fact that the component of gravity is acting against the projectile. This will necessitate a plus correction in range or an increase in the angle of departure. When the target is below the gun the converse is true and the projectile will range beyond the target, requiring a decrease in the angle of departure. The French make this correction by use of the Complimentary Angle of Site tables, where the correction to be added or subtracted from the angle of site is given in degrees and minutes.

In our service it has been customary in the past to correct for the error in the Theory of the Rigidity of the Trajectory by means of the "F" Table. This checks approximately with the French Tables for direct fire. With high angle fire, however, the French Tables will probably be found more accurate, and will give greater corrections.

To use the "F" Tables, multiply the height of site (difference in level of gun and target in feet) by the expression $\frac{1134 + .005R}{R}$, where R equals the range in yards. The result will give the value of the angle of site in minutes corrected for error in the Theory of the Rigidity of the Trajectory.

SOLUTION—HEIGHT OF SITE (CORRECTED FOR RIGIDITY)

Function	Formula	5000	10,000	15,000
F	$\frac{1134+.005R}{R}$	.2318	.1184	.0806
ε corrected for rigidity $= \Delta\varphi_h$	$\Delta\varphi_h = Fh$	34.77′	17.76′	12.09′
Q. A. D.	$\varphi_2 = \varphi \pm \Delta\varphi_h$	3°37.77′	7°12.56′	12°11.89′
A	$A = \frac{\text{Sin } 2\varphi_2}{C}$	.01071	.02111	.03502
Z	Table II.	1483.8	2628.7	3858.7
X_2 (Range in ft).	$X_2 = CZ$	17,500 ft.	31,001 ft.	45,511 ft.
Range Correction	$R_2 - R$	+833 yds.	+385 yds.	+170 yds.

(3) Correction for second part of the first Range Table Assumption, i. e., that the earth is flat, or that there is no curvature.

NOTE.—This correction is necessary when the difference in level between the gun and the target is determined from contours on a map. This correction is automatically made when determining difference in level between the gun and the target by means of a B. C. telescope, or other similar angular reading instrument, placed near the guns.

It will be noted that the correction for curvature is always negative.

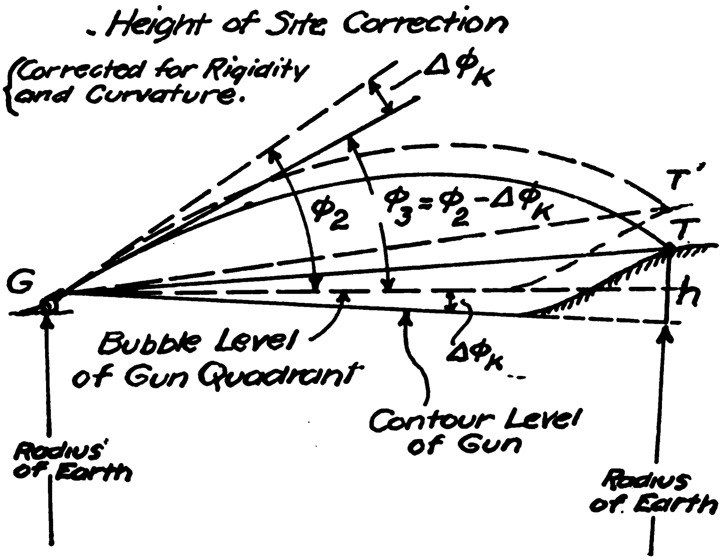

Height of Site Correction
(Corrected for Rigidity and Curvature.
$\Delta\phi_K$
T'
T
ϕ_2
$\phi_3 = \phi_2 - \Delta\phi_K$
G
h
Bubble Level of Gun Quadrant
$\Delta\phi_K$
Contour Level of Gun
Radius of Earth
Radius of Earth

FIG. 4.

In the above Figure $\varphi_3 = \varphi_1$ of Figure 2 corrected for curvature and rigidity.

or $\varphi_3 = \varphi \pm \Delta\varphi_h - \Delta\varphi_k$ where $\Delta\varphi_h$ is the correction for rigidity, and

$\Delta\varphi_k$ (curvature correction) in minutes is found from the expression $\Delta\varphi_k = \frac{R}{4000}$

K (curvature in feet) can be found from the expression $K = [3.3332619 - 10]\ R^2$, where R = Range.

SOLUTION.

Height of Site (Corrected for Rigidity and Curvature)

Function	Formula	5000	10,000	15,000
φ_2	$\varphi_2 = \varphi \pm \Delta\varphi_h$	3°37.77′	7°12.56′	12°11.89′
$\Delta\varphi_k$, curvature	$\Delta\varphi_k = \frac{R}{4000}$	1.25′	2.50′	3.75′
Q.A.D.	$\varphi_3 = \varphi_2 - \Delta\varphi_k$	3°36.52′	7°10.06′	12°8.14′
A	$A = \frac{\sin 2\varphi_3}{C}$	.01065	.02099	.03485
Z	Table II.	1476.5	2616.8	3845.2
X_3 (range in ft).	$X_3 = CZ$	17,414 ft.	30,863 ft.	45,351 ft.
Range Correction	$R_3 - R$	+805 yds.	+288 yds.	+117 yds.

Let us now tabulate the Range Corrections found in (1). (2) and (3) above and compare the results obtained.

Height of Site Correction	5000	10,000	15,000
Assuming Theory of Rigidity $\varphi_1 = \varphi \pm \varepsilon$	+827 yds.	+325 yds.	+162 yds.
Corrected for Rigidity $\varphi_2 = \varphi \pm \Delta\varphi_h$	+833 yds.	+335 yds.	+170 yds.
Corrected for Rigidity and Curvature $\varphi_3 = \varphi \pm \Delta\varphi_h - \Delta\varphi_k$	+805 yds.	+288 yds.	+117 yds.

See Problem 5, p. 18 and pp. 29-38, N B., and also pp. 76-77, G. H. A.

The following method of determining the approximate range correction for height of site is sometimes used in the field:

Let x = Range Correction for Height of Site.
and ω = Angle of Fall

$$\text{Then Tan } \omega = \frac{h}{x}, \text{ or } x = \frac{h}{\tan \omega} = h \text{ Cot } \omega$$

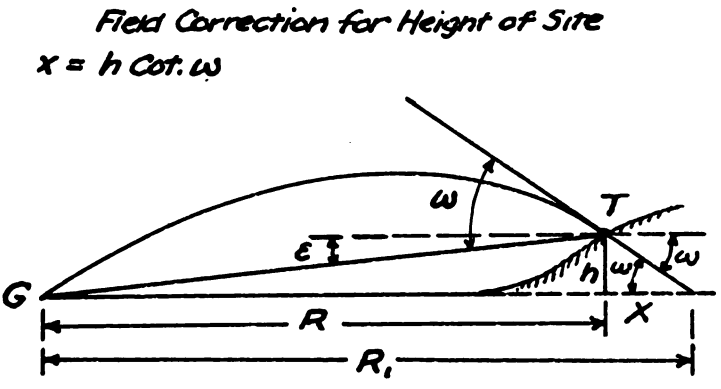


FIG. 5.

NOTE.—It will be seen that this method is only a rough approximation as the angle of site is neglected.

(b) CORRECTION FOR THE SECOND RANGE TABLE ASSUMPTION, i. e., THAT THE ATMOSPHERE IS NORMAL (TEMPERATURE 15° C, BAROMETER 750 mm., SATURATION 78 PER CENT.)

Compute points on atmosphere correction curve at ranges of 5000, 10,000 and 15,000 yards when the barometer reads 29″, and the thermometer reads 30°F.

Method (See Chapter XI, G. H. A.):

From Table A, p. 178, we find $\frac{\delta_1}{\delta} = .96$, which corresponds to a loss in the Ballistic Coefficient of 4 per cent.

Reference number would be, 16-4 or 12.

(NOTE.—Same reference number of 12 would be obtained by using Atmosphere Slide Rule for the above conditions).

Formulæ Used:

$$C_1 = \frac{w}{id^2} \cdot \frac{\delta_1}{\delta}$$

$Z = \frac{X}{C_1}$ Find from Table II corresponding value of A for Z and V.

$\text{Sin } 2\varphi_1 = AC_1$ Solve for φ_1.

From Range Table (Part 1) find range R corresponding to φ.

From Range Table (Part 1) find range R_1 corresponding to φ_1.

Therefore, Range Correction $= R_1 - R$.

Plot this point on the atmosphere correction curve Fig. 1.

NOTE.—In case no Range Table is available proceed as indicated in following Solution:

ATMOSPHERIC DENSITY

Function	Formula	5000	10,000	15,000
Ballistic Coef. of the Day	$C_1 = \frac{\delta_1}{\delta} C$	11.3227	11.3227	11.3227
Z	$Z = \frac{X}{C_1}$	1324.8	2649.6	3974.4
A_1	Table II.	.00943	.02132	.03650
Q. A. D.	$\text{Sin } 2\varphi_1 = A_1C_1$	3°3.87′	6°59.06′	12°12.30′
A	$A = \frac{\text{Sin } 2\varphi_1}{C}$	.009053	.020467	.03504
Z	Table II	1277.6	2564.3	3860.3
X_1	$X_1 = CZ$	15,068 ft.	30,244 ft.	45,529 ft.
Range Correction	$R_1 - R$	+23 yds.	+81 yds.	+176 yds.

See Probs. 1, 2, 4, and 5 pp. 15 – 18 N. B and prob. 12, p. 40 N. B., and also prob. p. 113, G. H. A.

(c) CORRECTION FOR THIRD RANGE TABLE ASSUMPTION, i. e., THAT THERE IS NO WIND.

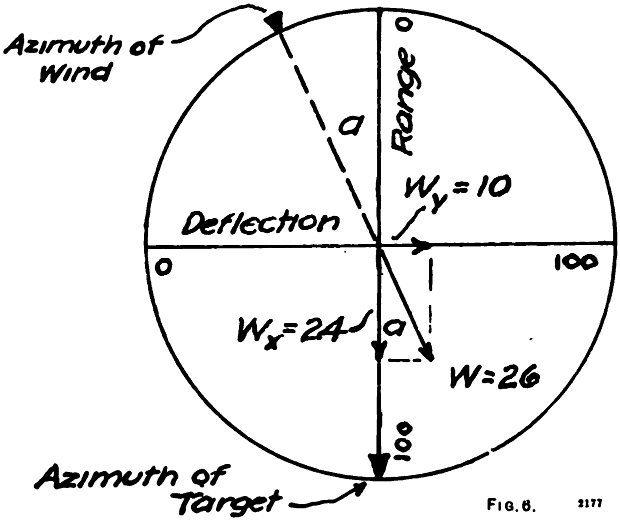


FIG. 6. 2177

Compute points on the wind correction curve at ranges of 5000, 10,000 and 15,000 yards, when the azimuth of the wind is 168°, the azimuth of the target 10.62° and the velocity of he wind is 26 miles per hour. (See Chapter X, G. H. A.)

Wind Component Indicator Relations, (see Fig. 6).

$a = 22.62°$ $W = 26$ miles per h.

$W_x = W \operatorname{Cos} a = 24$ miles per h.

$W_y = W \operatorname{Sin} a = 10$ miles per h.

and, $W^2 = W_x^2 + W_y^2$

From Wind Component Indicator, $W_x = 24$ miles per h., therefore, Wind Reference Number $= 50 + 24 = 74$ (accelerating wind).

Formulæ Used:

$C_1 = \frac{w}{id^2} \cdot f_w$, where $f_w = 1 \pm \frac{2W_x T^{5/4}}{X}$

$Z = \frac{X}{C_1}$, from table II, find corresponding value of A for Z and V.

$\operatorname{Sin} 2\varphi_1 = AC_1$, solve for φ_1.

From Range Table (Part I) find range R corresponding to φ.

From Range Table (Part I) find range R_1 corresponding to φ_1.

Therefore, *Range Correction* = $R_1 - R$.

Plot this point on the Wind Correction Curve (See Fig. 1).

NOTE: In case no Range Table is available proceed as indicated in following solution:

WIND

Function	Formula	5000	10,000	15,000
Wind Factor,	$f_w = 1 \pm \frac{2W_x \cdot T^{5/4}}{X}$	1.03803	1.05068	1.06383
Bal. Coef. of the Day.	$C_1 = f_w C$	[1.08786]	[1.09314]	[1.09853]
Z	$Z = \frac{X}{C_1}$	1225.3	2420.1	3586.6
A_1	Table II	.00864	.01905	.03166
Q. A. D.	$\sin 2\varphi_1 = A_1 C_1$	3°2.15′	6°49.64	11°42.15
A	$A = \frac{\sin 2\varphi}{C}$	.00897	.02002	.03368
Z	Table II	1267.1	2519.1	3751.6
X_1	$X_1 = CZ$	14,944 ft.	29,711 ft.	44,247 ft.
Range Correction	$R_1 - R$	−19 yds.	−96 yds.	−253 yds.

See probs. 1, 2, 4 and 5 pp. 15-18, N. B. and prob. 13 p. 42 N. B., also prob. p. 107 G. H. A.

(d) CORRECTION FOR FOURTH RANGE TABLE ASSUMPTION i e., THAT THE MUZZLE VELOCITY OF THE POWDER IS STANDARD, OR 2250 f. s.

Compute points on the Muzzle Velocity Correction Curve at ranges of 5,000, 10,000 and 15,000 yards, for a Muzzle Velocity of 2270 f. s. (See Chapter IX, G. H. A.)

Reference Number 2270.

Formulæ Used:

$Z = \frac{X}{C}$, from Table II, find value of A_1 corresponding to Z and a Muzzle Velocity of 2270 f.s.

$\sin 2\varphi_1 = A_1 C$, solve for φ_1.

From Range Table (Part I) find range R corresponding to φ.

From Range Table (Part I) find range R_1 corresponding to φ_1.

Therefore, *Range Correction* = $R_1 - R$.

Plot this point on the Muzzle Velocity Curve (see Fig. 1).

Note.—In case no Range Table is available proceed as indicated in following Solution:

Function	Formula	Muzzle Velocity 5000	10,000	15,000
Z	$Z = \frac{X}{C}$	1271.8	2543.6	3815.4
A_1	Table II	.00886	.01991	.03388
Q. A. D.	$\sin 2\varphi_1 = A_1.C$	2°59.94′	6°47.64′	11°46.57′
A_1	$A_1 = \frac{\sin 2\varphi_1}{C}$	.00886	.01991	.03388
Z_1	Table II	1253.2	2508.1	3767.7
X_1	$X_1 = CZ_1$	14,781 ft.	29,581 ft.	44,437 ft.
Range Correction	$R_1 - R$	−73 yds.	−140 yds.	−188 yds.

See probs. 4 and 5, pp. 18-19, N. B. and pp. 45-48, N. B.

PART III.

CONSTRUCTION OF DEFLECTION CORRECTION CHART

(a) Compute deflection correction curve for the same cross wind as determined from the Wind Component Indicator in Part II (c) of this problem, and for drift at ranges of 5000, 10,000 and 15,000 yards. (See Chapter XII, G. H.A.)

Note.—In firing at a stationary target, there are but two deflection corrections, wind and drift. Wind is a variable correction. Drift is to the right, and is constant for the same range. We can, therefore, correct each wind deflection correction for any range by the constant drift correction for that same range—and thus correct for both wind and drift on the same curve Remember the following rules when using our present model sea coast sight.:

R—R, To shoot right—Raise.
L—L, To shoot left—Lower. (pp. 48-50, N. B.)

(1) CORRECTION FOR DEFLECTION COMPONENT OF WIND. (P. 17, N. B. and prob. p. 127 G. H. A.)

Wind deflection (degrees) = $\frac{W_y Z}{V} . D^\circ_w$

Where: W_y = 10 from Wind Comp. Ind., Part II (c).

$Z = \frac{X}{C}$ $V = \text{M.V.} = 2250$ f. s.

D°_w is taken from Table D, (see p. 183).

Reference Number: (See Fig. 6).

NOTE.—From Wind Component Indicator, Part II (c) the wind is blowing right to left, 10 mi. per hour. To hit target we must shoot right. To shoot right, Raise. Normal Reference Number = 50. Therefore, Reference Number = 50 + 10 = 60.

(2) CORRECTION FOR DRIFT.

(P. 17, N. B. and also p. 126 G. H. A.)

Drift (degrees) = $(1 - K)\frac{d^3}{wn}(\varphi + \omega)$ Sec φ.

where K (constant) = .75, and n (twist) = 25.

To obtain deflection correction, add algebraically 1 and 2 above.

Plot these corrections for 5000, 10,000 and 15,000 yards, and obtain a curve for the reference number 60, (See Fig. 7).

SOLUTION FOR DEFLECTION

Function	Formula	5000	10,000	15,000
Wind Deflection	$\frac{W_y Z}{V} . D^\circ_w \ (\frac{D}{\text{Table}})$	+.032°	+.068°	+.111°
Drift	$D = (1-K)\frac{d^3}{wn}$ $(\varphi+\omega)$ sec. φ	−.104°	−.252°	−.470°
Deflection (Wind and Drift Combined)	Add algebraically (1) and (2) above	−.072°	−.184°	−.359°

PART IV.

(a) CORRECTION FOR VARIATION IN MUZZLE VELOCITY DUE TO A VARIATION IN WEIGHT OF PROJECTILE.

Assume a lot of projectiles are received which are 4 pounds under standard weight. What change in Muzzle Velocity will result?

$$\Delta V = \frac{-7}{16} \frac{\Delta w}{w} V$$

Plot M. V. correction curve for variations of 2 lbs., 4 lbs., 6 lbs. in weight of projectile. (See Fig. 7).

It should be borne in mind that although the initial muzzle velocity will be greater with a lighter projectile, yet the value of the ballistic coefficient will be cut down, and the two will tend to compensate each other. (See p. 88, G. H. A.)

(b) CORRECTION FOR VARIATION IN MUZZLE VELOCITY DUE TO VARIATIONS IN WEIGHT OF POWDER CHARGE.

Assume a lot of powder charges are received, which are 6 pounds overweight. What change in muzzle velocity will result? (See p. 87, G. H. A.)

$$\frac{V}{V_1} = \left(\frac{w}{w_1}\right)^y$$

Where y for smokeless powder = 1.2 and for nitroglycerine powder = 0.8. Plot M. V. correction curve for variations of 2 lbs., 4 lbs., 6 lbs., above standard weight of powder charge. (See Fig. 7).

Function	Formula	Δ_w = 2 lbs.	Δ_w = 4 lbs.	Δ_w = 6 lbs.
Muzzle Velocity corrected for Weight of Projectile	$\Delta V = -\frac{7}{16} \cdot \frac{\Delta w}{w} V$	+1.843 f.s.	+3.694 f.s.	+5.551 f.s.
Muzzle Velocity corrected for Weight of Powder	$\frac{V}{V_1} = \left(\frac{w}{w_1}\right)^y$	2266 f.s.	2282 f.s.	2299 f.s.

(See pp. 50-51 N. B.)

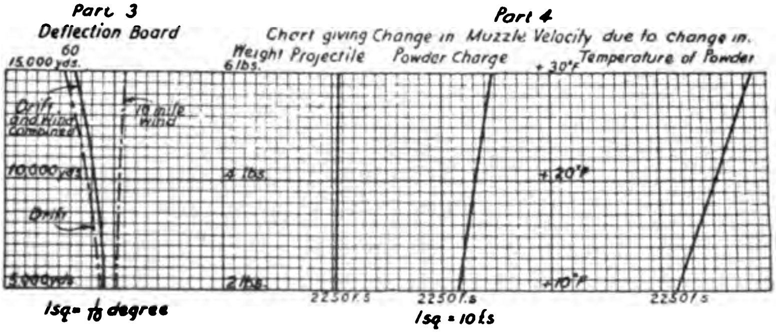


FIG 7.

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(c) CORRECTION FOR VARIATION IN TEMPERATURE OF POWDER CHARGE.

Assume temperature of powder magazine in which the powder has been stored for a period of two weeks is 80° F. What change in muzzle velocity will result? From the following table (taken from G. O. No. 5, W. D. 1910) we find a correction of +24 f. s., or 2274 f. s. (See p. 86, G. H. A.)

NORMAL MUZZLE VELOCITES

F°	833	917	980	1056	1148	1220	2000	2100	2150	2200	2250	2400	2600
−10	27	30	32	34	38	40	65	67	69	71	72	77	84
0	26	29	31	33	37	39	63	66	67	69	70	75	81
+10	25	28	29	31	35	37	60	62	64	66	67	71	77
20	23	26	27	29	32	34	55	58	59	61	62	66	71
30	20	23	24	25	29	30	49	51	53	54	55	59	64
40	17	19	20	21	24	25	41	43	44	46	46	49	53
50	13	14	15	16	18	19	30	32	33	34	34	36	39
60	7	8	8	9	10	10	17	18	18	19	19	20	22
70	0	0	0	0	0	0	0	0	0	0	0	0	0
80	9	9	10	11	12	13	21	22	22	23	24	26	28
90	19	21	22	24	26	28	46	48	50	50	52	56	60
100	32	35	37	41	44	47	77	81	82	84	87	92	100

Deduct corrections for temperatures below 70°; add for above 70°. Plot M. V. correction curve due to temperature of powder charge of 80°F, 90°F and 100°F. (See Fig. 7).

PART V.

Given a new U. S. Range Table, (tentative form), transfer data computed in parts I, II, III, and IV, of this problem to the new Range Table converting data into the French units of measure by means of the appended conversion table. (See p. *vi* appendix G. H. A.)

Data	Unit of Measure	5000	10,000	15,000
Range	Meters	4572	9144	13,716
Angle of Departure	Mils	54.2	122.8	213.2
dR for ± 1 mil El	Meters.	74	58	43
dR for ± 10 m/s M. V.	"	119	210	282
dR for ± 10 per cent of C	"	53	185	402
dR for + 1 kg. wt. of Proj.	"	−6	−9	−9
dR for ± 10 m/s Wind	"	16	80	214
Drift	Mils	1.8	4.4	8.3
Deflection for 10 m/s cross wind.	"	1.2	2.7	4.3
Angle of Fall	"	60.3	152.4	292.4
Slope of Fall	$^1/_x$	$\frac{1}{16.86}$	$\frac{1}{6.63}$	$\frac{1}{3.39}$
Time of Flight	Seconds	7.24	15.87	26.40
Maximum Ordinate	Meters	64.2	308.8	853.9
Striking Velocity	Meters per sec.	584.2	496.6	427.6
*Value of C	U.S. Units	11.7945	11.7945	11.7945

*A constant value of C was used in the above computations. This is only approximately true for direct fire. In high angle fire C will vary with the elevation and its value, as determined by experimental firing, will be given in the new range tables as a function of the range.

Linear and Angular Measurements

The fundamental unit of the metric system is the meter. From this unit of length the units of capacity (liter), and weight (gram), are derived. All other units are the decimal subdivisions or multiples of these. These three units are related by the fact that 1 cubic decimeter equals 1 liter, and 1 liter of water at a standard temperature weighs 1 kilogram.

The metric tables are formed by combining the words "meter", "gram", and "liter" with the six numerical prefixes shown in the following table.

Prefix	Meaning	As. Com. Fra.	As Decimal	Units
Mili	One thous'th.	1/1000	.001	"Meter"
Centi	One hund'th	1/100	.01	for length
Deci	One tenth	1/10	.1	"Gram"
				for weight
Unit	One	1	1.	or mass.
Deka	Ten	10/1	10.	"Liter"
Hecto	One hundred	100/1	100.	for
Kilo	One thousand	1000/1	1000.	Capacity

The international meter = 39.37 inches, hence 1 yard = 3600/3937 meter. We will omit further reference to the gram (unit of weight and mass) and the liter (unit of capacity) since we are mainly concerned with the inter-relation of French and American units of linear measurements. In the absence of extended conversion tables the following conversion factors or constants will be found useful in transforming quantities from one unit or system to another.

Milimeters	x	.03937	=	Inches
Inches	x	25.400	=	Millimeters
Meters	x	3.280833	=	Feet
Feet	x	.3048	=	Meters
Kilometers	x	.621377	=	Miles
Miles	x	1.60935	=	Kilometers

Temperature Conversion. F° and C°

Fahrenheit to Centigrade

$$5/9\,(F^\circ - 32) = C^\circ$$
$$9/5\,C^\circ + 32 = F^\circ$$

WEIGHT CONVERSION

Kilograms	x	2.2046	=	Pounds
Pounds	x	.4536	=	Kilograms
Metric Tons (1000 kg.)	x	1.1023	=	Tons (2000 lbs)
Tons (2000 lbs.)	x	.9072	=	Metric Tons (1000 Kilograms)

ABBREVIATIONS (U. S. BUREAU OF STANDARDS):

Milimeter = mm		Meter	=m	Inch	= in.
Centimeter = cm		Dekameter	=dkm	Foot	= ft.
Decimeter = dm		Hectometer	=hm	yard	= yd.
		Kilometer	=km	Mile	= mi.

1 Nautical or Sea Mile = 6080.20 ft. = 1.151533 mi. = 1853.249 meters.

This value is that established by the U. S. Coast and Geodetic Survey as being the length of 1 min. of arc of the great circle of a perfect sphere co-areal. It is ordinarily termed a knot.

Data	Unit of Measure	5000	10,000	15,000
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CIRCULAR MEASURE

In what may be termed the American or customary system, the circle is considered as being divided into 360 primary divisions called degrees (°), and each degree into 60 minutes ($'$), and each minute into 60 seconds ($''$).

THE U. S. FIELD ARTILLERY MIL

The circle is divided into 6400 primary divisions called mils. The arc subtended by an angle of 1 mil is practically 1/1000 of the radius (range). The exact arc for an angle of 1 mil with a radius or range of 1000 meters is .98175 meters.

Hence the three rules:

1. $\text{Deflection angle in mils} \times \dfrac{\text{Range in meters}}{1000} = \text{Lateral deviation in meters.}$

2. $\text{Lateral deviation in meters} \div \dfrac{\text{Range in meters}}{1000} = \text{Deflection in mils.}$

3. $\dfrac{\text{Lateral deviation in meters}}{\text{Deflection in mils}} \times 1000 = \text{Range in meters.}$

THE GRAD

The circle is divided into 400 primary units called grads (^{g}), and each grad into 10 decigrads, and each decigrad into 10 centesimal minutes ($'$). Each centesimal minute is divided into 100 centesimal seconds ($''$).

1 grad = 10 decigrads = 100 centesimal minutes = 10,000 centesimal seconds. 10 grads = 1 dekagrad.

Units	Inches	Feet	Yards	Miles	Centimeters	Meters
1 Inch =	1^-	.083333	.027778	.000015783	2.540005	.025400
1 Foot =	12.	1.	.333333	.000189394	30.48006	.304801
1 Yard =	36.	3.	1.	.000568182	91.44018	.9144018
1 Mile =	63360.	5280.	1760.	1.	160934.72	1609.3472
1 cm =	.3937	.03280833	.0109361	.0000062137	1.	.01
1 Meter =	39.37	3.280833	1.0936111	.00062137	100.	1.

ANGULAR CONVERSION TABLE

Units	Degrees	Minutes	Seconds	Mils	Grads
1 Degree	1.	60.	3600.	17.7778	1.111111
1 Minute	.0166667	1.	60.	.296296	.0185185
1 Second	.00027778	.0166667	1.	.0049383	.000308642
1 Circle	360.	21600.	129600.	6400.	400.
1 Mil	.05625	3.375	202.5	1.	.0625
1 Grad	.9	54.	324.	16.	1.

The following tables, taken from "Notes on Ballistics," "Artillery Notes," and "Ingall's Table II, Artillery Circular M," have been added to complete this problem without reference to other works being necessary.

TABLE A

Values of δ_1/δ for temperature and pressure of atmosphere 78% saturated with moisture. (From *Artillery Note No. 25.*)

Ther. F.	Barometer				Ther. F.	Barometer			
	28"	29"	30"	31"		28"	29"	30"	31"
—20°	0.890	0.861	0.831	0.806	5°	0.942	0.909	0.880	0.851
—19°	0.892	0.863	0.833	0.808	6°	0.944	0.911	0.881	0.853
—18°	0.894	0.864	0.835	0.809	7°	0.946	0.913	0.883	0.855
—17°	0.896	0.866	0.837	0.811	8°	0.948	0.915	0.885	0.856
—16°	0.898	0.868	0.839	0.813	9°	0.950	0.917	0.887	0.858
—15°	0.901	0.870	0.841	0.815	10°	0.952	0.919	0.889	0.860
—14°	0.903	0.872	0.843	0.816	11°	0.954	0.921	0.890	0.862
—13°	0.905	0.874	0.845	0.818	12°	0.956	0.923	0.892	0.864
—12°	0.907	0.876	0.847	0.820	13°	0.958	0.925	0.894	0.866
—11°	0.910	0.878	0.848	0.822	14°	0.960	0.927	0.897	0.867
—10°	0.912	0.880	0.850	0.824	15°	0.962	0.929	0.899	0.869
— 9°	0.914	0.881	0.852	0.826	16°	0.964	0.931	0.901	0.871
— 8°	0.916	0.883	0.854	0.827	17°	0.966	0.933	0.903	0.873
— 7°	0.918	0.885	0.856	0.829	18°	0.968	0.935	0.905	0.875
— 6°	0.920	0.887	0.858	0.831	19°	0.971	0.937	0.907	0.877
— 5°	0.922	0.889	0.860	0.833	20°	0.973	0.939	0.909	0.879
— 4°	0.924	0.891	0.862	0.835	21°	0.975	0.941	0.911	0.881
— 3°	0.926	0.893	0.864	0.836	22°	0.977	0.943	0.912	0.883
— 2°	0.928	0.895	0.866	0.838	23°	0.979	0.945	0.914	0.885
— 1°	0.930	0.897	0.868	0.840	24°	0.981	0.947	0.916	0.887
0°	0.932	0.899	0.870	0.842	25°	0.983	0.949	0.918	0.888
1°	0.934	0.901	0.871	0.844	26°	0.985	0.951	0.920	0.890
2°	0.936	0.903	0.873	0.845	27°	0.987	0.953	0.922	0.892
3°	0.938	0.905	0.876	0.847	28°	0.990	0.955	0.924	0.894
4°	0.940	0.907	0.878	0.849	29°	0.992	0.958	0.926	0.896

Table A—Continued.

Ther.	Barometer				Ther.	Barometer			
F.	28″	29″	30″	31″	F.	28″	29″	30″	31″
30°	0.994	0.960	0.928	0.898	66°	1.073	1.035	1.001	0.968
31°	0.996	0.962	0.930	0.899	67°	1.075	1.037	1.003	0.970
32°	0.998	0.964	0.932	0.902	68°	1.078	1.040	1.005	0.973
33°	1.000	0.966	0.934	0.903	69°	1.080	1.042	1.007	0.975
34°	1.003	0.968	0.936	0.906	70°	1.082	1.044	1.009	0.977
35°	1.005	0.970	0.938	0.907	71°	1.085	1.046	1.011	0.979
36°	1.007	0.972	0.940	0.909	72°	1.087	1.048	1.013	0.981
37°	1.009	0.974	0.943	0.911	73°	1.089	1.050	1.015	0.983
38°	1.011	0.976	0.945	0.913	74°	1.092	1.053	1.017	0.985
39°	1.013	0.978	0.947	0.915	75°	1.094	1.055	1.019	0.987
40°	1.015	0.980	0.949	0.917	76°	1.096	1.057	1.022	0.989
41°	1.017	0.982	0.951	0.919	77°	1.099	1.059	1.025	0.992
42°	1.019	0.984	0.953	0.921	78°	1.101	1.062	1.027	0.994
43°	1.021	0.987	0.955	0.923	79°	1.104	1.064	1.029	0.996
44°	1.023	0.989	0.957	0.925	80°	1.106	1.066	1.031	0.998
45°	1.026	0.991	0.959	0.927	81°	1.109	1.068	1.033	1.000
46°	1.028	0.993	0.961	0.929	82°	1.111	1.071	1.035	1.002
47°	1.030	0.995	0.963	0.931	83°	1.114	1.074	1.038	1.005
48°	1.033	0.997	0.964	0.933	84°	1.116	1.076	1.041	1.007
49°	1.035	0.999	0.966	0.935	85°	1.119	1.079	1.043	1.009
50°	1.037	1.002	0.968	0.937	86°	1.121	1.081	1.045	1.011
51°	1.040	1.004	0.970	0.939	87°	1.124	1.083	1.047	1.013
52°	1.042	1.006	0.972	0.941	88°	1.126	1.086	1.049	1.016
53°	1.044	1.008	0.974	0.943	89°	1.129	1.089	1.053	1.018
54°	1.046	1.010	0.976	0.945	90°	1.131	1.092	1.055	1.020
55°	1.048	1.012	0.978	0.947	91°	1.134	1.094	1.057	1.022
56°	1.050	1.014	0.980	0.949	92°	1.136	1.096	1.059	1.025
57°	1.053	1.016	0.982	0.951	93°	1.139	1.099	1.062	1.027
58°	1.055	1.018	0.984	0.952	94°	1.142	1.102	1.064	1.029
59°	1.057	1.020	0.986	0.954	95°	1.144	1.105	1.066	1.031
60°	1.059	1.022	0.988	0.956	96°	1.147	1.107	1.068	1.033
61°	1.062	1.025	0.990	0.958	97°	1.149	1.110	1.071	1.035
62°	1.064	1.027	0.992	0.960	98°	1.152	1.112	1.074	1.037
63°	1.066	1.029	0.994	0.962	99°	1.155	1.115	1.076	1.040
64°	1.068	1.031	0.996	0.964	100°	1.157	1.117	1.079	1.042
65°	1.071	1.033	0.998	0.966					

TABLE B

(Taken from Ingalls' Table II, *Artillery Circular M*)
$V = 2200$ f.s.

$Z = \frac{X}{C}$	$\log B'$	Δ_z	u	Δ_z	T'	Δ_z	$\log C'$	Δ_z
							−10	
100	0.0036	36	2173	27	0.046	46	4.8266	35
200	0.0072	36	2146	26	0.092	47	4.8301	36
300	0.0108	37	2120	27	0.139	47	4.8337	36
400	0.0145	36	2093	26	0.186	48	4.8373	36
500	0.0181	37	2067	26	0.234	49	4.8409	37
600	0.0218	37	2041	26	0.283	49	4.8446	37
700	0.0255	37	2015	25	0.332	50	4.8483	37
800	0.0292	37	1990	26	0.382	51	4.8520	37
900	0.0329	37	1964	25	0.433	51	4.8557	38
1000	0.0366	38	1939	25	0.484	52	4.8595	38
1100	0.0404	37	1914	25	0.536	52	4.8633	39
1200	0.0441	38	1889	24	0.588	54	4.8672	39
1300	0.0479	37	1865	25	0.642	54	4.8711	39
1400	0.0516	38	1840	24	0.696	54	4.8750	39
1500	0.0554	38	1816	23	0.750	56	4.8789	39
1600	0.0592	38	1793	24	0.806	56	4.8828	40
1700	0.0630	38	1769	23	0.862	57	4.8868	40
1800	0.0668	38	1746	23	0.919	58	4.8908	40
1900	0.0706	39	1723	22	0.977	58	4.8948	41
2000	0.0745	38	1701	22	1.035	59	4.8989	41
2100	0.0783	38	1679	22	1.094	60	4.9030	41
2200	0.0821	39	1657	21	1.154	61	4.9071	41
2300	0.0860	38	1636	22	1.215	62	4.9112	42
2400	0.0898	38	1614	21	1.277	62	4.9154	41
2500	0.0936	38	1593	21	1.339	64	4.9195	42
2600	0.0974	38	1572	20	1.403	64	4.9237	42
2700	0.1012	38	1552	21	1.467	65	4.9279	43
2800	0.1050	38	1531	20	1.532	65	4.9322	42
2900	0.1088	38	1511	20	1.597	67	4.9364	43
3000	0.1126	38	1491	20	1.664	67	4.9407	43
3100	0.1164	38	1471	19	1.731	68	4.9450	43
3200	0.1202	38	1452	19	1.799	69	4.9493	43
3300	0.1240	37	1433	19	1.868	70	4.9536	43
3400	0.1277	38	1414	19	1.938	71	4.9579	44
3500	0.1315	38	1395	18	2.009	73	4.9623	44
3600	0.1353	37	1377	17	2.082	73	4.9667	44

TABLE B

(Taken from Ingalls' Table II, *Artillery Circular M*)

$V = 2200$ f.s.

$Z = \frac{X}{C}$	log B'	Δ_z	u	Δ_z	T'	Δ_z	log C'	Δ_z
							−10	
3700	0.1390	38	1360	18	2.155	74	4.9711	44
3800	0.1428	37	1342	17	2.229	75	4.9755	45
3900	0.1465	38	1325	16	2.304	76	4.9800	45
4000	0.1503	37	1309	16	2.380	77	4.9845	45
4100	0.1540	37	1293	16	2.457	78	4.9890	45
4200	0.1577	36	1277	16	2.535	78	4.9935	46
4300	0.1613	35	1261	15	2.613	80	4.9981	45
4400	0.1648	34	1246	14	2.693	81	5.0026	46
4500	0.1682	34	1232	14	2.774	81	5.0072	46
4600	0.1716	33	1218	14	2.855	83	5.0118	45
4700	0.1749	33	1204	13	2.938	83	5.0163	46
4800	0.1782	32	1191	12	3.021	85	5.0209	46
4900	0.1814	31	1179	12	3.106	85	5.0255	46
5000	0.1845	31	1167	12	3.191	86	5.0301	46
5100	0.1876	29	1155	11	3.277	87	5.0347	46
5200	0.1905	29	1144	10	3.364	88	5.0393	46
5300	0.1934	27	1134	11	3.452	89	5.0439	46
5400	0.1961	26	1123	10	3.541	89	5.0485	46
5500	0.1987	26	1113	10	3.630	90	5.0531	46
5600	0.2013	24	1103	9	3.720	91	5.0577	45
5700	0.2037	23	1094	9	3.811	92	5.0622	45
5800	0.2060	23	1085	9	3.903	93	5.0667	46
5900	0.2083	21	1076	8	3.996	93	5.0713	45
6000	0.2104	21	1068	8	4.089	94	5.0758	45
6100	0.2125	20	1060	8	4.183	95	5.0803	45
6200	0.2145	19	1052	7	4.278	96	5.0848	45
6300	0.2164	18	1045	8	4.374	96	5.0893	44
6400	0.2182	17	1037	7	4.470	97	5.0937	44
6500	0.2199	17	1030	7	4.567	97	5.0981	44
6600	0.2216	16	1023	7	4.664	98	5.1025	44
6700	0.2232	16	1016	6	4.762	99	5.1069	43
6800	0.2248	14	1010	7	4.861	99	5.1112	43
6900	0.2262	14	1003	6	4.960	100	5.1155	43
7000	0.2276	13	997	6	5.060	101	5.1198	43

TABLE B

(Taken from Ingalls' Table II, *Artillery Circular M*)
$V = 2300$ f.s.

$Z = \frac{X}{C}$	og B'	Δ_z	u	Δ_z	T'	Δ_z	log C'	Δ_z
							−10	
100	0.0036	35	2272	28	0.044	44	4.7878	35
200	0.0071	36	2244	28	0.088	45	4.7913	35
300	0.0107	36	2216	27	0.133	45	4.7948	36
400	0.0143	36	2189	27	0.178	46	4.7984	36
500	0.0179	36	2162	27	0.224	47	4.8020	36
600	0.0215	36	2135	27	0.271	47	4.8056	37
700	0.0251	36	2108	26	0.318	48	4.8093	37
800	0.0287	37	2082	26	0.366	48	4.8130	37
900	0.0324	37	2056	26	0.414	49	4.8167	37
1000	0.0361	37	2030	26	0.463	50	4.8204	38
1100	0.0398	37	2004	25	0.513	50	4.8242	38
1200	0.0435	37	1979	25	0.563	51	4.8280	38
1300	0.0472	37	1954	25	0.614	51	4.8318	38
1400	0.0509	37	1929	25	0.665	52	4.8356	39
1500	0.0546	38	1904	25	0.717	53	4.8395	39
1600	0.0584	37	1879	24	0.770	54	4.8434	39
1700	0.0621	38	1855	24	0.824	54	4.8473	39
1800	0.0659	38	1831	24	0.878	55	4.8512	40
1900	0.0697	38	1807	23	0.933	56	4.8552	40
2000	0.0735	38	1784	23	0.989	56	4.8592	40
2100	0.0773	38	1761	23	1.045	57	4.8632	41
2200	0.0811	38	1738	23	1.102	58	4.8673	40
2300	0.0849	38	1715	22	1.160	59	4.8713	41
2400	0.0887	38	1693	22	1.219	60	4.8754	42
2500	0.0925	38	1671	22	1.279	60	4.8796	41
2600	0.0963	39	1649	22	1.339	61	4.8837	42
2700	0.1002	38	1627	21	1.400	62	4.8879	42
2800	0.1040	38	1606	21	1.462	63	4.8921	42
2900	0.1078	39	1585	21	1.525	63	4.8963	42
3000	0.1117	38	1564	21	1.588	64	4.9005	42
3100	0.1155	37	1543	20	1.652	65	4.9047	43
3200	0.1192	38	1523	20	1.717	66	4.9090	43
3300	0.1230	38	1503	20	1.783	67	4.9133	43
3400	0.1268	38	1483	19	1.850	68	4.9176	44
3500	0.1306	38	1464	19	1.918	69	4.9220	44
3600	0.1344	38	1445	19	1.987	70	4.9264	44

TABLE B

(Taken from Ingalls' Table II, *Artillery Circular M*)

$V = 2300$ f. s.

$Z = \frac{X}{C}$	log B'	Δ_z	u	Δ_z	T'	Δ_z	log C'	Δ_z
							−10	
3700	0.1382	38	1426	19	2.057	70	4.9308	44
3800	0.1420	38	1407	18	2.127	71	4.9352	44
3900	0.1458	38	1389	18	2.198	73	4.9396	45
4000	0.1496	38	1371	18	2.271	73	4.9441	45
4100	0.1534	38	1353	18	2.344	74	4.9486	45
4200	0.1572	38	1335	17	2.418	76	4.9531	45
4300	0.1610	37	1318	17	2.494	76	4.9576	45
4400	0.1647	36	1301	16	2.570	77	4.9621	46
4500	0.1683	36	1285	16	2.647	78	4.9667	46
4600	0.1719	35	1269	15	2.725	79	4.9713	46
4700	0.1754	35	1254	15	2.804	81	4.9759	46
4800	0.1789	34	1239	14	2.885	81	4.9805	46
4900	0.1823	34	1225	13	2.966	82	4.9851	46
5000	0.1857	34	1212	13	3.048	83	4.9897	46
5100	0.1891	33	1199	12	3.131	84	4.9943	47
5200	0.1924	32	1187	12	3.215	85	4.9990	46
5300	0.1956	31	1175	12	3.300	86	5.0036	47
5400	0.1987	30	1163	12	3.386	87	5.0083	46
5500	0.2017	29	1151	11	3.473	87	5.0129	47
5600	0.2046	28	1140	10	3.560	88	5.0176	46
5700	0.2074	26	1130	11	3.648	89	5.0222	47
5800	0.2100	26	1119	10	3.737	90	5.0269	46
5900	0.2126	25	1109	9	3.827	90	5.0315	47
6000	0.2151	24	1100	9	3.917	91	5.0362	47
6100	0.2175	23	1091	9	4.008	92	5.0409	47
6200	0.2198	22	1082	9	4.100	93	5.0456	46
6300	0.2220	22	1073	8	4.193	94	5.0502	46
6400	0.2242	20	1065	8	4.287	94	5.0548	46
6500	0.2262	20	1057	8	4.381	95	5.0594	45
6600	0.2282	19	1049	8	4.476	95	5.0639	46
6700	0.2301	18	1041	7	4.571	96	5.0685	45
6800	0.2319	17	1034	7	4.667	97	5.0730	44
6900	0.2336	16	1027	7	4.764	98	5.0774	45
7000	0.2352	15	1020	6	4.862	99	5.0819	45

TABLE C

(From *Ballistics*, Part I, Hamilton)

Values of the coefficient of form, for projectiles the heads of which are of ogival radius *n* calibers.

n	c
2	1.00
3	0.82
4	0.71
5	0.64
6	0.58
7	0.54

NOTE: Assumed value of i = .63 for 12-inch long-pointed projectile.

TABLE D

(From *Ballistics*, Part I, Hamilton)

Values of D_w in degrees, for use with the formula,

$$\text{Deflection for } W \text{ mile wind} = \frac{W_y Z}{V} \,.\, D_w^\circ$$

V	1600	1700	1800	1900	2000	2100
Z	°	°	°	°	°	°
0000	.0055	.0055	.0055	.0054	.0054	.0053
1000	.0059	.0058	.0058	.0057	.0057	.0056
2000	.0061	.0060	.0061	.0060	.0060	.0059
3000	.0061	.0062	.0063	.0063	.0063	.0062
4000	.0060	.0062	.0063	.0065	.0065	.0065
5000	.0059	.0061	.0064	.0066	.0067	.0067
6000	.0057	.0061	.0065	.0066	.0068	.0069
7000	.0055	.0060	.0064	.0065	.0068	.0070
8000	.0054	.0059	.0062	.0064	.0067	.0070
9000	.0053	.0057	.0060	.0063	.0066	.0069
10000	.0052	.0056	.0059	.0062	.0066	.0069
11000	.0051	.0055	.0058	.0061	.0065	.0068
12000	.0051	.0054	.0058	.0061	.0064	.0067
13000	.0050	.0054	.0057	.0061	.0063	.0067
14000	.0050	.0053	.0057	.0060	.0062	.0066
15000	.0049	.0053	.0056	.0059	.0062	.0065
16000	.0049	.0053	.0056	.0059	.0062	.0065
17000	.0049	.0052	.0055	.0058	.0061	.0064
18000	.0049	.0052	.0055	.0058	.0061	.0064
19000	.0048	.0052	.0055	.0057	.0060	.0063
20000	.0048	.0051	.0054	.0057	.0060	.0063
21000	.0048	.0051	.0054	.0057	.0060	.0062

TABLE D—Continued.

V	2100	2200	2300	2400	2500	2600
Z	°	°	°	°	°	°
0000	.0053	.0052	.0051	.0050	.0049	.0048
1000	.0056	.0056	.0055	.0054	.0053	.0052
2000	.0059	.0059	.0058	.0057	.0056	.0055
3000	.0062	.0062	.0061	.0060	.0059	.0059
4000	.0065	.0065	.0064	.0063	.0063	.0063
5000	.0067	.0068	.0067	.0067	.0067	.0067
6000	.0069	.0070	.0070	.0070	.0070	.0070
7000	.0070	.0071	.0072	.0072	.0072	.0072
8000	.0070	.0071	.0072	.0073	.0074	.0074
9000	.0069	.0071	.0072	.0074	.0075	.0076
10000	.0069	.0072	.0072	.0074	.0075	.0076
11000	.0068	.0070	.0071	.0073	.0075	.0076
12000	.0067	.0069	.0071	.0073	.0075	.0076
13000	.0067	.0069	.0071	.0073	.0074	.0076
14000	.0066	.0068	.0070	.0072	.0074	.0076
15000	.0065	.0068	.0070	.0072	.0074	.0076
16000	.0065	.0067	.0069	.0072	.0073	.0075
17000	.0064	.0067	.0069	.0071	.0073	.0075
18000	.0064	.0067	.0069	.0071	.0073	.0075
19000	.0063	.0066	.0069	.0071	.0073	.0075
20000	.0063	.0066	.0068	.0071	.0073	.0075
21000	.0062	.0065	.0068	.0071	.0073	.0075

V	2600	2700	2800	2900	3000	3100
Z	°	°	°	°	°	°
0000	.0048	.0048	.0047	.0047	.0046	.0046
1000	.0052	.0051	.0050	.0050	.0049	.0048
2000	.0055	.0054	.0054	.0053	.0052	.0051
3000	.0059	.0058	.0057	.0056	.0055	.0054
4000	.0063	.0062	.0060	.0060	.0059	.0058
5000	.0067	.0066	.0064	.0063	.0063	.0062
6000	.0070	.0069	.0068	.0067	.0066	.0065
7000	.0072	.0072	.0072	.0071	.0070	.0069
8000	.0074	.0075	.0075	.0074	.0074	.0073
9000	.0076	.0077	.0077	.0077	.0077	.0077
10000	.0076	.0077	.0078	.0078	.0079	.0079
11000	.0076	.0078	.0079	.0079	.0080	.0081
12000	.0076	.0078	.0079	.0080	.0081	.0082
13000	.0076	.0078	.0079	.0080	.0081	.0082
14000	.0076	.0078	.0079	.0081	.0082	.0083
15000	.0076	.0078	.0079	.0081	.0082	.0083
16000	.0075	.0077	.0079	.0081	.0082	.0083
17000	.0075	.0077	.0079	.0081	.0082	.0084
18000	.0075	.0077	.0079	.0081	.0082	.0084
19000	.0075	.0077	.0079	.0081	.0083	.0084
20000	.0075	.0077	.0079	.0081	.0083	.0084
21000	.0075	.0077	.0079	.0081	.0083	.0084

TABLE D—Continued

V	3100	3200	3300	3400	3500	3600
Z	°	°	°	°	°	°
0000	.0046	.0045	.0045	.0044	.0044	.0043
1000	.0048	.0047	.0047	.0046	.0046	.0045
2000	.0051	.0050	.0050	.0049	.0048	.0047
3000	.0054	.0053	.0053	.0052	.0051	.0050
4000	.0058	.0057	.0057	.0056	.0055	.0053
5000	.0062	.0061	.0060	.0059	.0058	.0056
6000	.0065	.0064	.0063	.0062	.0061	.0060
7000	.0069	.0068	.0067	.0066	.0065	.0064
8000	.0073	.0072	.0071	.0070	.0069	.0068
9000	.0077	.0076	.0075	.0075	.0073	.0073
10000	.0079	.0079	.0078	.0078	.0077	.0077
11000	.0081	.0081	.0081	.0081	.0080	.0080
12000	.0082	.0082	.0083	.0083	.0083	.0083
13000	.0082	.0083	.0084	.0084	.0085	.0085
14000	.0083	.0084	.0085	.0085	.0086	.0086
15000	.0083	.0084	.0085	.0086	.0087	.0088
16000	.0084	.0085	.0086	.0086	.0087	.0088
17000	.0084	.0085	.0086	.0087	.0088	.0089
18000	.0084	.0085	.0087	.0088	.0089	.0090
19000	.0084	.0086	.0087	.0086	.0089	.0090
20000	.0084	.0086	.0087	.0089	.0090	.0091
21000	.0084	.0086	.0087	.0089	.0090	.0091

TABLE E

(From *Ballistics*, Part I, Hamilton)

Table of values of percentage changes in muzzle velocity of powders tested at 70° F. and fired with a magazine temperature t° F.

t	$\Delta V/V$	ΔV for $V =$ 2000	2250	2500
0°	−.0323	−65	−73	−81
10°	−.0302	−60	−67	−75
20°	−.0275	−55	−62	−69
30°	−.0241	−48	−54	−60
40°	−.0199	−40	−45	−50
50°	−.0147	−29	−33	−36
60°	−.0082	−16	−18	−20
70°	−.0000	0	0	0
80°	.0101	20	23	25
90°	.0228	46	52	58
100°	.0387	77	87	96

DIAGRAMS SHOWING SIMILARITY OF COAST ARTILLERY GUNNERY TO HEAVY ARTILLERY GUNNERY.

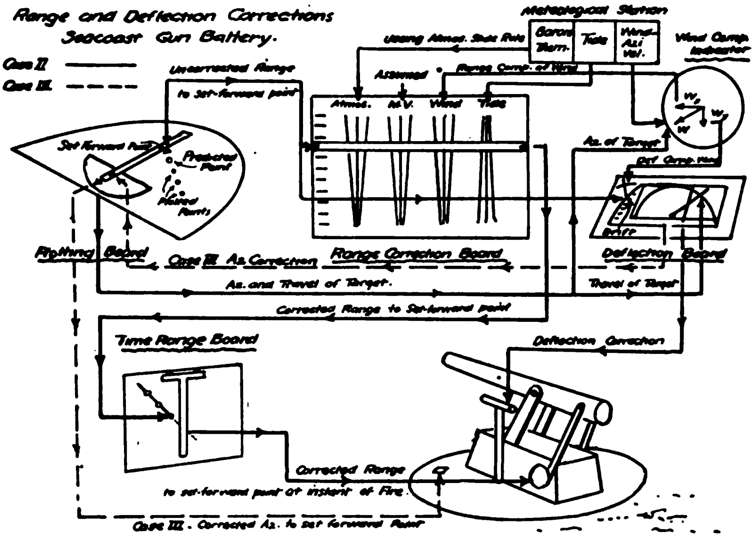

FIG. 8.

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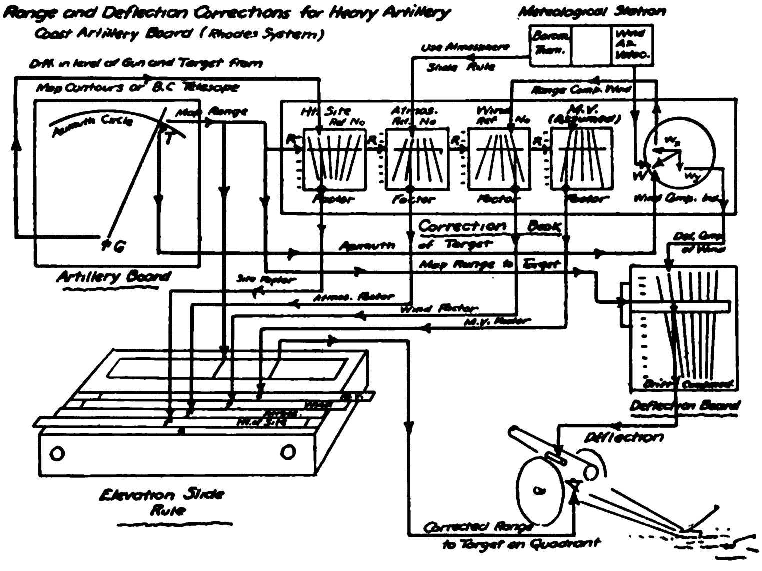


FIG. 9.

2180

Notes on Inclined Trajectories

By Maj. F. M. Green, C.A., and Maj. C. W. Green, C.A.

While nearly all applications of practical gunnery methods are dependent upon the principle of the rigidity of the trajectory, it is well known that a rigorous application of this principle may lead to material error. Thus, it is generally recognized that for inclined trajectories where the target is above the gun, the addition of the position angle to the range table angle will give an insufficient quadrant elevation, and further elevation must be given the piece in order to hit the target.

Similarly, when the target is below the gun, it is known that the subtraction of the depression angle ϵ from the range table value of φ will leave too great a remainder for the quadrant elevation, leading to over-shooting. To hit the target, the piece must be further depressed. The necessity for this correction in seacoast practice was recognized about four years ago, and elevation tables have since been constructed by the use of the "F-table" (pp. 32-3, "Notes on Ballistics," Wildrick). The use of this table is very simple, and up to ranges of about 20,000 yards, it leads to results in close accord with those derived from Ingalls' general expression. This convenient approximation is unsuited for use except with batteries of fixed position firing at naval targets; accordingly, it need not be further considered here.

Since mobile pieces may be required to attack targets at levels considerably above or below the initial plane, a consideration of inclined trajectories becomes especially important for officers normally assigned to artillery of position, but now about to serve mobile matériel. On page 9 of Artillery Circular " N," Col. Ingalls gives the formula that

$$\sin (2\varphi - \epsilon) = \sin \epsilon \, (1 + \cot \epsilon \sin 2\varphi_x)$$

where

ϵ is the position angle as shown;

φ_x is the range table angle of departure to attain the range

GP = GT cos ϵ; and

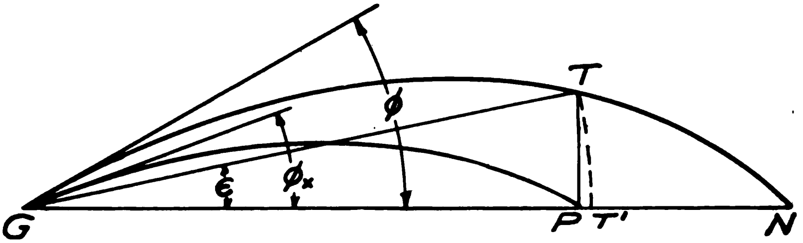
φ is the required quadrant angle of departure to hit a target at T. Solution of this expression leads to the following awkward formula for the quadrant elevation:

$$\varphi = \sin^{-1}\left\{\frac{\sin\epsilon}{\sqrt{2}}\sqrt{2+\cot\epsilon\left[\sin 2\varphi_x+\cot\epsilon\pm\sqrt{\cot^2\epsilon-\cot\epsilon\sin 2\varphi_x(2+\cot\epsilon\sin 2\varphi_x)}\right]}\right\} \tag{A.}$$

This formula is obviously too inconvenient to admit of its direct application to specific cases as they arise in the field. We may write the expression for the quadrant elevation to hit a target at T, assuming perfect rigidity of the trajectory, in the form that

$$\varphi = \varphi(GT') + \epsilon \tag{B}$$

noting that T and T′ lie on a circular arc whose center is at G. However, in practice, the distance GT′ is seldom found; the range obtained from the map or by co-ordinate computation



is its horizontal projection GP, equal to GT cos Θ, and the difference between GP and GT′ is disregarded. We then have the form

$$\varphi = \varphi(GP) + \epsilon = \varphi_x + \epsilon \tag{C}$$

which is the form according to which the principle of rigidity is customarily applied.

Owing to the involved character of formula "A," it is difficult to compare it with "C." It may, in general, be said that for trajectories of moderate curvature and inclination, the discrepancy between the results obtained by the two methods will be small.

We may rewrite "A" in the form $\varphi = f(\epsilon, \varphi_x)$ and "C" may be represented in the same way. It is accordingly evident that the difference of the results obtained by the two methods will be a function of ϵ and φ_x. Thus, we may write A in the more convenient form that

$$\varphi = \varphi_x + \epsilon + f(\epsilon, \varphi_x)$$

From this we can see that we may prepare a table of $f(\epsilon, \varphi_x)$ which is perfectly general, applicable to any charge for any piece, and which gives as a function of φ_x and ϵ the *amount* of the correction which must be applied to formula "C" to cause its results to agree exactly with those which would have resulted from a solution of the more complicated formula "A." To prepare such a table, it is necessary only to solve Ingalls' general expression (see third paragraph of these notes) for any assumed conditions of φ_x and ϵ, and to compare the resulting values of φ with those derived from "C" under similar assumptions. The differences thus obtained are tabulated in French range tables under the head of "Complementary angle of site," with the remark that the sign of this correction is the same as the sign of the angle of site.

So long as formula "C" is used (as is always done when the range is obtained from map co-ordinates, artillery board, planchette de tir, or seacoast plotting board, where no attempt is made to correct for the difference in length of GP and GT), the above principle will always be found to hold; viz.: that the sign of the complementary angle will be the same as that of the angle of site.

However, the complementary angle of site as above defined and used must not be confused with the correction required to be applied to a rigorous rigidity solution by formula "B." Thus, in the case of very flat trajectories at different inclinations, some rather involved effects will be found if the results by formulas "A" and "B" are compared. A study of the high-fire range tables for the .30 cal. machine gun or the 3-inch anti-aircraft rifle indicates as follows: for any particular radial distance from gun to target, the necessary angle between the line of sight and the axis of the bore ("sight elevation") is a function of the position angle. In general, the necessary sight elevation will at first be found to increase as the target rises from the horizon; the duration of this period of increase will be found to increase with the distance of the target from the gun. The required sight elevation will then reach a maximum; after passing the maximum point, it will be found to decrease with increasing rapidity as the target approaches the zenith, becoming zero as the target reaches a position directly above the gun. This extreme case illustrates the existence of a negative correction to the result obtained by the use of a rigorous rigidity assumption (formula "B"). It does not, however, indicate any reversal of the sign of the complementary angle of site as previously defined: viz.: as the correction to be applied to formula "C" to reconcile its results with those which would have been obtained by the more laborious solution of formula "A".

It is of interest to note that if in high fire the distance gun-target be used as an argument for finding the sight elevation, an assumption of perfect rigidity (formula B) will in most cases cause the gun to shoot over the target. This will occur when

$$\varphi_x + \epsilon + \kappa < \varphi_{T'} + \epsilon$$

where κ represents the true complementary angle of site and $\varphi_{T'}$ represents the elevation required to cause a projectile to range a distance GT′, equal to the inclined range GT. Eliminating ϵ from both numbers, and replacing $\varphi_{T'}$, by $\varphi_x + \Delta\varphi$ where $\Delta\varphi$ is the increment of elevation to attain the increment of range PT′, we have

$$\varphi_x + \kappa < \varphi_x + \Delta\varphi$$

or when $\Delta\varphi > \kappa$, the assumption of rigidity will cause overshooting. The point where the principle of the rigidity of the trajectory can be applied without error (that is, where $\Delta\varphi = \kappa$) will depend upon the relative values of the variables of which $\Delta\varphi$ and κ are functions. As has been previously shown, κ is a function of φ_x and ϵ, while $\Delta\varphi$ is not only a function of the distance PT′ (which for any value of GT is a function of ϵ) but also will vary with the slope of fall between P and T′, thus depending upon the initial velocity and ballistic coefficient for any particular range. When $\Delta\varphi < \kappa$, the use of formula "B" will cause the shots to fall short.

The foregoing discussion must not occasion confusion as regards fire against terrestrial targets when the range is accepted as the horizontal projection of the line joining gun and target. In this case, the complementary angle of site κ to be added to the algebraic sum of φ_x and ϵ will always be of the same sign as is the angle of site.

The above discussion has been based upon Ingalls' formula because of the simplicity of its application. More exact and refined methods have recently been developed for the computation of the trajectories of anti-aircraft armament. Failure of Ingalls' formula to give results in exact accord with the latest range table may be in part explained by the absence of the altitude factor in his expression. A difference of 500 meters between gun and target may alter the ballistic coefficient 3 per cent. In this connection, it has been suggested that for heavy guns firing at targets several hundred meters above or below the battery, the existing practice of taking the air density at the level of the battery is productive of material error. Computation would appear to support this view. Whether or not greater accuracy would actually result by reducing the temperature and pressure to that probably existing at a point midway in height between battery and target, is not known.

With regard to the use of tables of complementary angle of site, the following may serve to clear up some confusion which has been experienced: where the complementary angle of site is expressed as a function of φ_x and ϵ, and all three are expressed in angular units, the table is perfectly general, and is applicable to guns of any type, or to the same gun at any velocity. When, however, the complementary angle is expressed as a range correction (e. g., in meters), or when the complementary angle of site is expressed in angular units but is tabulated with range as an argument (instead of φ_x in angular units) the table is not general, but applies only to a particular gun and charge. It is now proposed to include in our new range tables for heavy mobile guns a combination table showing the sum of the corrections (probably in meters) for the angle of site proper, the complementary angle of site, and the curvature of the earth. Separate tables are then required for each charge. In such tables some negative values will be found in the table showing corrections for the target above gun. These are explained by the fact that contour differences are employed as an argument in place of ϵ, but at long ranges where the curvature of the earth exceeds the difference between the contour levels of gun and target, the target may be actually below the initial plane, even though its contour level is greater than that of the battery.

Effect of the Earth's Rotation Upon the Point of Fall[1]

By Major Fred M. Green, C. A., and
Major C. W. Green, C. A.

That correction is sometimes made for the influence of earth's rotation in preparing firing data for pieces of long range, is generally known. The following discussion, while it is neither complete nor rigid, is offered as a possible means for approximating the amount of this correction in any particular case. As yet, the rotation correction has not been considered in reducing range firings in our service; it is therefore evident that the following corrections are not properly applicable when firing with any of our existing range tables. As improved matériel is developed, and the ranges of our artillery increase, this effect will have to be eliminated in the reduction of range firings, and subsequent corrections will have to be applied in the computation of firing data, as is now done in the French service for firing at extreme ranges.

The calculation of the effect of the earth's rotation upon the point of fall of a projectile is best prefaced by a consideration of the effect of a difference in velocity of gun and target.

The principal symbols and units employed are here tabulated for convenience of reference, in the order of their introduction:

B = position of battery.
T = position of target.
t = range table time of flight, in seconds. Assumed to be the mean time of flight observed in firing at all azimuths, or the time corresponding to the case of a practically motionless earth.
P = position of the projectile along its trajectory at the end of time t.
V_B = velocity of battery, in meters per sec., due to the earth's rotation.

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[1] The assistance and helpful criticism of Capt. C. B. Brull, 82nd Heavy Artillery, French Army, are gratefully acknowledged by the writers.

V_T = velocity of target, in meters per sec., due to the earth's rotation.
D = deviation of P from T, in meters.
(Should a linear unit other than the meter be used in expressing V_B and V_T, D will be expressed in that unit.)
β = angle between paths of gun and target.
V_D = vectorial difference of velocities between V_B and V_T.
α = angle between path of target and line TP, in radians
E_r = mean radius of earth, in meters, = 6,367,450.
ω = angular velocity of rotation of the earth in radians per second, which numerically equals $\frac{1}{13,713}$ (mean solar day = 23 hours, 56 minutes, 4 seconds. $\pi = 3.1416$).
L = latitude.
δ = angle of fall.
Θ = azimuth.

For L, δ and Θ any convenient angular system may be used.

Let the gun be at B and the target at T. With no motion of either gun or target a shot falls at T with a time of flight, t. Now if B and T move with equal velocities in an easterly direction (Fig. 1) and the gun is again fired with the same setting as before, the shot will again fall at T, because the velocity of B relative to T, $(V_B - V_T)$, is still zero.

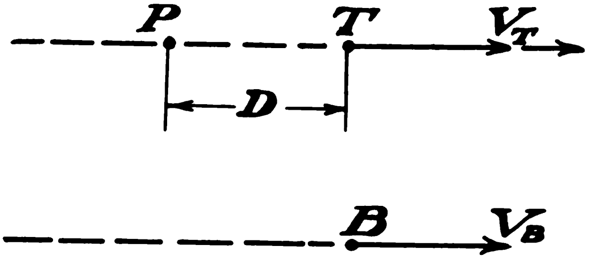

Fig. 1

Now suppose T to move in the same direction but at a velocity greater than that of B, and let the piece be fired at T as before. At the end of time t, the shot will evidently fall at some point, P, behind T and on the line of its path. Its distance from T will be equal to the difference in velocities of B and T multiplied by the time of flight.

$$D = t\,(V_B - V_T) \qquad (1)$$

If $V_T > V_B$ the shot will fall in front of T, or P will be ahead of T instead of behind it as in Fig. 1. A gun firing at a target due north or south of its position is an example of these conditions, as will be shown later.

Next, consider the target, T, moving at the same velocity as B, but with its path making the angle β with the path of B. (Fig. 2.) The shot which would strike T if B and T were both stationary, will now fall at a distance from T which is determined in magnitude and direction by the vector difference in veclocities of the two points multiplied by the time of flight, as was shown in the preceding case. Thus

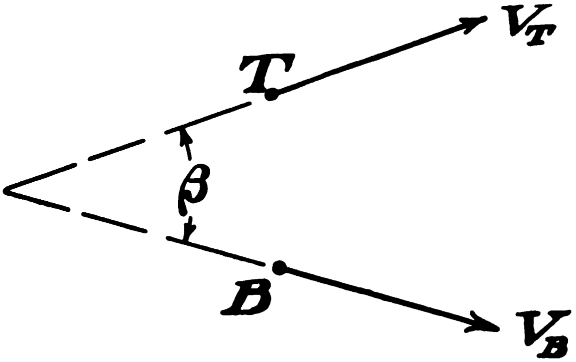

Fig. 2

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$$D = t\,(V_B - V_T) = tV_D, \qquad (2)$$

the indicated subtraction being made in a vectorial sense. In other words, V_D represents the velocity of B relative to T.

To determine D, we lay off V_B and V_T as vectors equal in length and making the angle β with each other. (Fig. 3). The value V_D thus found, multiplied by t, will give the distance from the target to the point P. The angle between V_T and V_D is called α, and this angle thus found will equal the angle between the course of the target and the line from T to P; the position of the latter point is thus completely determined. If the angle β is small, it will be seen that α may be taken as virtually 90°; the point P will then lie in the plane of the two velocity vectors, on a line through T perpendicular to its course

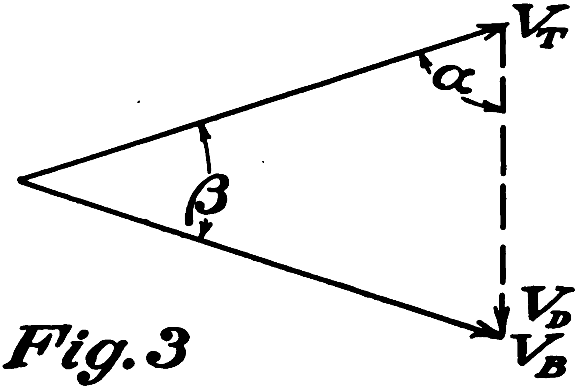

Fig. 3

(V_T) and distant from T by the amount D, whose value is given by equation (2).

APPLICATIONS

(1). When a gun is fired at a target due north or south of the piece, B and T are in the same meridian, and we have the condition of parallel velocities of unequal magnitude. Let E_r be the mean radius of the earth in meters, ω its angular velocity in radians per second, and L the latitude. From Fig. 4, noting that when < BCT is decreased, < BTU approaches the latitude of B as its limit, we then have $BU = TB \sin L = R \sin L$.

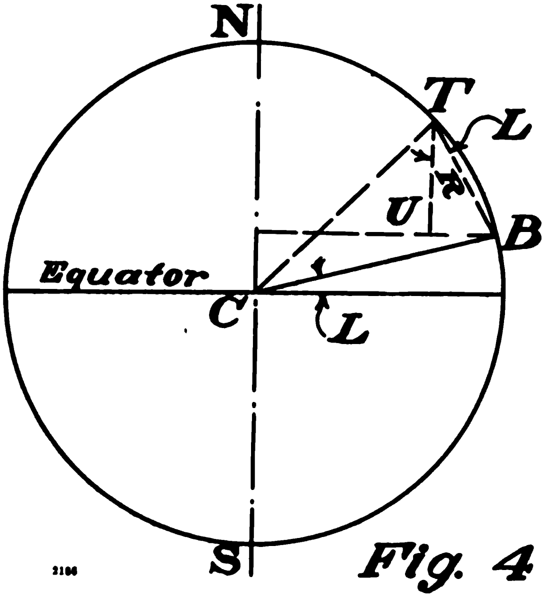

Fig. 4

Then

$V_B = \omega E_r \cos L$

$V_T = \omega (E_r \cos L - R \sin L)$

$V_B - V_T = V_D = \omega R \sin L$, and from equation (2),

$$D = \omega t R \sin L \qquad (3)$$

The shot will fall on the parallel of latitude which passes through the target, and at a distance from it equal to ω t R sin L. In the northern hemisphere, the point of fall will be to the right of the target as viewed from the battery, regardless of whether the firing be directed toward the north or south. This is true because in firing north the point B (Fig. 1) has the greater linear velocity, and the shot will fall ahead of T on its path produced (or will have a right deviation) while in fire to the south T has the greater velocity, and the shot strikes behind, or to the west of, T, which again is to the right of the target as seen from the battery. This of course considers rotational deviations only; drift, lateral wind and errors in laying may cause a resultant deviation in either direction.

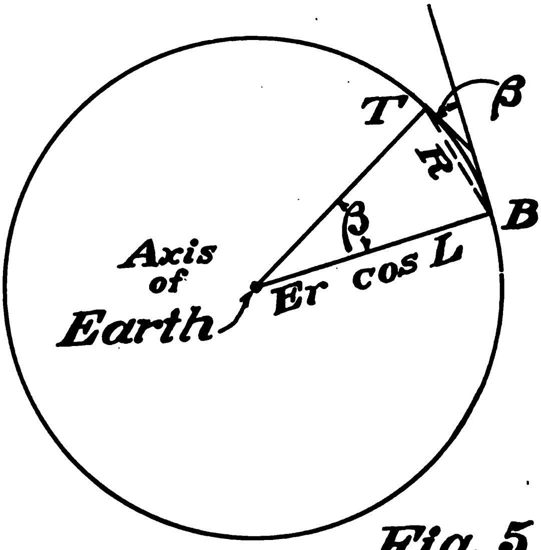

Fig. 5

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(2). When a gun is fired at a target due east or west of e piece, points B and T lie on the circumference of a circle t by a plane parallel to the equatorial plane. Call the lati- le of this circle L. At any instant, the velocities of B and T in the direction of tangents drawn to the circle at these points. Accordingly, we have the condition of equal velocities which differ in direction by a small angle. Fig. 5 represents the condition as viewed from the north pole.

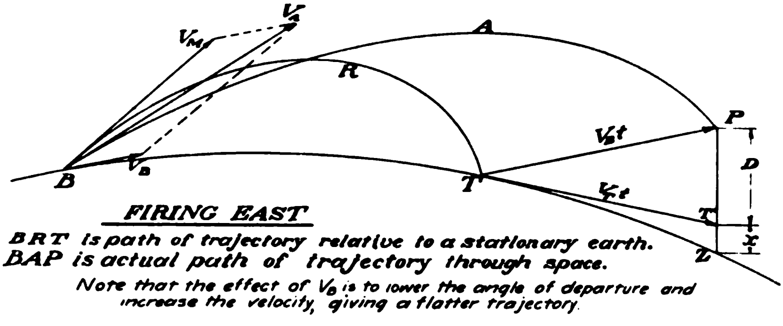
$$V_B = V_T = \omega E_r \cos L \qquad (4)$$

$$\beta = \frac{R}{E_r \cos L} \text{ radius} \qquad (5)$$

The acceptance of the equality of the arc and chord in (5) is productive of no error of consequence, for the angle subtended at the earth's axis by any artillery trajectory is very small. Laying off these vectors as in Fig. 3, and solving for V_D, we have for small values of β, $V_D = \beta V_B$, so by substitution from (4) and (5), $V_D = \frac{R}{E_r \cos L} \omega E_r \cos L = \omega R$, and from equation (2)

$$D = \omega t R \qquad (6)$$

P, the position of the projectile along its path at the end of the time t, will lie in the plane of the parallel of latitude L, at a distance from T equal to ωtR, and on a line drawn through T, parallel to that radius of the parallel circle which bisects arc BT. This can best be seen by taking the vector velocities of B and T, and finding V_D as in Fig. 3. Its application will appear from a consideration of Figs. 6 and 7, in which the trajectories are viewed from the south, and each figure lies completely in the plane of its parallel circle. In these figures, the vectors VM and VA represent the muzzle velocity (or velocity of the projectile relative to the earth), and the absolute velocity of the projectile in space, respectively. The curvature of the earth is obviously exaggerated for the sake of clearness. Practically, for the small angles subtended at the earth's axis by



FIRING EAST

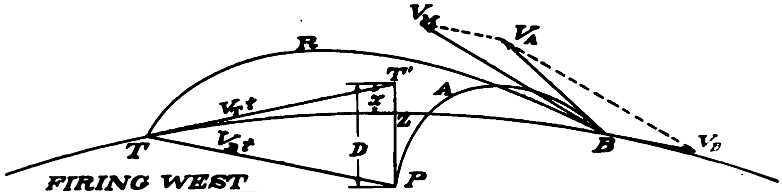
BRT is path of trajectory relative to a stationary earth.
BAP is actual path of trajectory through space.

Note that the effect of V_D is to lower the angle of departure and increase the velocity, giving a flatter trajectory.

Fig. 6

actual artillery ranges, we may for the purpose of this discussion approximate the position of P with sufficient exactness by substituting the condition that it lie on that radius of the parallel circle which passes through T. It will be noted that this approximation is identical with that made in the discussion of Fig. 3 for small values of β, where α was shown to be practically a right angle, for the radius through T is evidently perpendicular to the instantaneous velocity of T, or normal to its momentary path.

This determination of the length D (Figs. 6 and 7) is seen to be inexact, since point T actually moves on a circular path during the time of flight, whereas it was above assumed that it continued to move on a rectilinear path tangent to the parallel circle at T. Such an assumption will lead to one applying too small a correction for fire in an easterly direction (Fig. 6) and too large a correction when firing west (Fig. 7). By the assumption as made, the target at the end of time t would have travelled along the tangent at T a distance equal to tV_T. The position P of the projectile with reference to this point T′, is found as shown by equation (2):



BRT is path of trajectory relative to a stationary earth.
BAP is actual path of trajectory through space.

Note that the effect of V_B is to raise the angle of departure and decrease the velocity, giving a more curved trajectory.

Fig. 7

$$D = tV_D = t(V_B - V_T)$$

For firing east (Fig. 6), P will evidently lie above the surface of the earth, and when firing west (Fig. 7) it will lie below.

The distance x in these figures represents the actual deviation of the path of the target from a straight line. For eastward fire, D + x is the true displacement, and for westward fire, D − x is the true displacement. Since for any given range, x varies almost exactly as the square of t, and D varies as the first power, it follows that the error introduced will be of greater importance in the case of high-angle fire, where the time of flight is proportionally greater for a given range, than in direct fire. The effect of neglecting this correction x will lead to overshooting when firing in either an easterly or westerly direction with data based upon this discussion: in the former case our correction is "down," but is too small; in the latter case, our correction is "up" and is too great. For curved or high-angle fire, this approximation may lead to considerable error. A more exact, but less convenient, expression involving the distance x, is that

$$D' = D \pm x = \omega t R \pm \tfrac{1}{2} (\omega^2 t^2 E_T \cos L)$$

D′ may be substituted, for D in the remaining discussion and the working formulas modified accordingly, but for simplicity this refinement will be omitted.

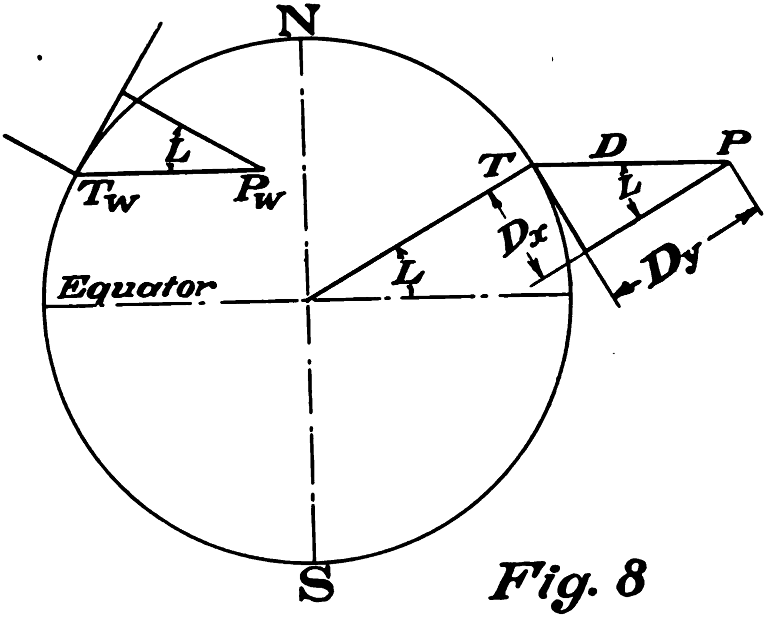


Fig. 8

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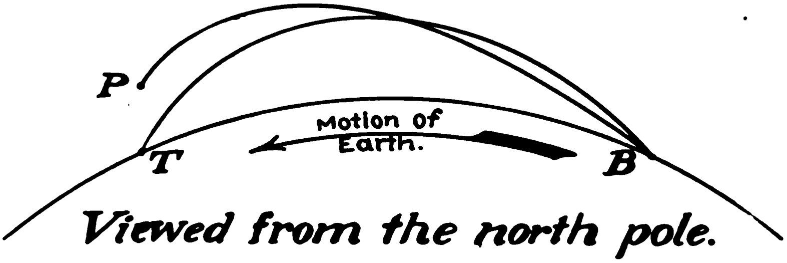
Fig. 8 is a section cut by the plane passing through the axis of the earth and point T. The distance D is laid off on the trace of a plane passed through T and parallel to the plane of the equator, for as was shown in the discussion of Figs. 3 and 5, V_D must lie in the plane of V_B and V_T. The distance laid off from T equals ωtR. In this figure, the observer may be considered as looking along the trajectory in the direction of the target. For eastward fire, the projectile is seen to be above and to the right of the target at the end of time t, remembering that a line through the center of the earth and through point T determines a vertical at the latter place. The lateral displacement of P from the target is not D, but the horizontal projection of D upon the tangent to the meridian circle at T. Call this D_x. Then the deviation to the right will be

$$D_x = D \sin L = \omega t \, R \sin L \qquad (7)$$

For fire in a westward direction, the position of the projectile at the end of time t will be, P_w (Fig. 8). This is now below the surface of the earth at T_w, but still to the right as viewed from the battery.

The lateral deviation is again as in (7), and the direction of this deviation is always to the right when firing in the northern hemisphere, for either eastward or westward fire.



Viewed from the north pole.

Fig. 9

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We must also consider the range deviation produced by the displacement of point P from the earth's surface. Consider the case of fire toward the east. In Fig. 9, let BT represent the trajectory which would be described were the earth stationary, and let P be the actual position of the projectile at the end of time t. From Fig. 8, preceding, it will be seen that the perpendicular distance from P to the earth equals

$$D_Y = D \cos L = \omega t R \cos L \qquad (8)$$

and if δ represent the angle of fall, then the increase in range will equal

$$\omega t R \cos L \cot \delta \qquad (9)$$

if the curvature of earth and of the trajectory be disregarded during descent from P.

A similar process of analysis will show that for fire toward the west, the decrease in range due to rotation may be determined from the same formula.

GENERAL CASE

Let a shot be fired at any azimuth θ, measured clockwise from the north at B. The rotational deviations may be determined by resolving the range R into two components,—a north or south component R cos θ, and an east or west component R sin θ. (See Fig. 10). Corresponding to the former, there will be a deviation in direction only; the latter will involve corrections both for direction and for range.

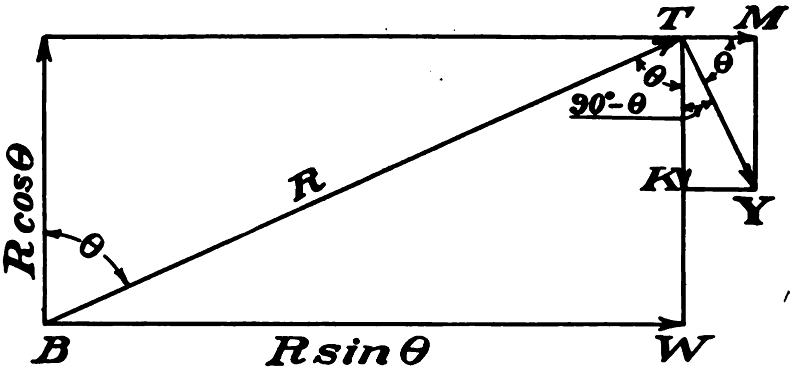

Fig. 10

Let D_1 represent the lateral deviation produced by the component R cos θ. From equation (3), substituting for R its particular value R cos θ, we have

$$D_1 = \omega t R \cos \theta \sin L \qquad (10)$$

This deviation is perpendicular to the meridian; to show its effect upon the point of fall, lay off TM as shown, equal to D_1.

Let D_2 be the lateral deviation consequent upon the eastward component of the range, or R sin θ. From formula (7), substituting for R its value of R sin θ for this case, we have

$$D_2 = \omega t R \sin \theta \sin L \qquad (11)$$

Lay off TK in Fig. 10, representing this deviation in magnitude and direction.

$$TY = \sqrt{TM^2 + TK^2} \tag{12}$$

being the diagonal of a rectangle. From (10) and (11) above, we see that

$$\frac{TM}{TK} = \frac{D_1}{D_2} = \cot \theta. \qquad \text{Hence } \angle MTY = \theta$$

so $\angle KTY = 90° - \theta$. But $\angle BTW = \theta$. Hence $\angle BTY = 90°$, and D_1 and D_2 cannot affect the range. The lateral deviation produced by them is evidently TY, or substituting from (10) and (11) into (12), we have that the lateral deviation equals

$$TY = \omega tR \sin L \tag{13}$$

At the end of time t, the projectile will be vertically above point Y; its height above the earth's surface is given by (8), which for the eastward component $R \sin \theta$ becomes

$$\omega tR \sin \theta \cos L$$

This will produce a range deviation of

$$\omega tR \sin \theta \cos L \cot \delta$$

where δ is the angle of fall for this range.

SUMMARY OF WORKING FORMULAS FOR FIRE AT ANY AZIMUTH

$$\text{Lateral deviation} = \omega tR \sin L$$

which is always to the right when firing in the northern hemisphere.

$$\text{Longitudinal deviation} = \omega tR \sin \theta \cos L \cot \delta$$

which will cause the shot to fall beyond the target when firing to the east of the meridian, or to fall short of the target if firing to the west.

EXAMPLES:

(1) 12-inch seacoast gun, 2250 f.s. M.V., 1070 lb. projectile, firing east from Fort Monroe.

Latitude = 37° N = L
Range = 24,936 yards = R
Time of flight = 53.39 sec. = t
Angle of fall = 37° 49′ = δ

$$\text{Deflection correction for rotation} = \omega t R \sin L = \frac{24{,}936}{13{,}713}(53.39)\,(.6018) = 58.4 \text{ yards, or } 0^\circ.13 \text{ left.}$$

$$\text{Range correction for rotation} = \omega t R \sin \Theta \cos L \cot \delta = \frac{24{,}936}{13{,}713}(53.39)\,(.7986)\,(1.2884) = 100 \text{ yards down.}$$

(2) Same piece, velocity and projectile, fired due northeast from the latitude of Paris (48° 50′).

Range = 18,300 meters
Time of flight = 38.25 seconds
Angle of fall = 25° 58′

$$\text{Deflection correction for rotation} = \omega t R \sin L = \frac{18{,}300}{13{,}713}(38.25)\,(.7528) = 38.6 \text{ meters, or } 2.1 \text{ mils left.}$$

$$\text{Range correction for rotation} = \omega t R \sin \Theta \cos L \cot \delta = \frac{18{,}300}{13{,}713}(38.25)\,(.7071)\,(.6583)\,(2.053) = 48.7 \text{ meters down.}$$

(3) German long-range gun firing west on Paris. Values assumed:—

Range = 109.3 km.
Time of flight = 180 sec.
Angle of fall = 60°

Deflection correction for rotation =

$$\frac{109{,}300}{13{,}713}(180)\,(.7528) = 1{,}084 \text{ meters.}$$

Range correction for rotation =

$$\frac{109{,}300}{13{,}713}(180)\,(.6583)\,(.5774) = 545 \text{ meters.}$$

Note particularly that the above problems are illustrative only; they are presented merely in order to give an idea of the magnitude of these corrections. For range less than about 20,000 yards, these corrections will generally be less than the uncertainty due to other factors, and their employment is accordingly inadvisable. The use of any correction for rotation is justified only when it is known that in the reduction of firings for the range table upon which it is based, the effect of earth's rotation has been eliminated. No such tables have yet been constructed in our service.

These formulas must not be considered as mathematically exact. In their derivation, there were numerous assumptions and approximations introduced. For example: in the absence of any lateral disturbing factors, a projectile actually travels in a plane passing through the center of the earth (cutting a great circle); corrections for this were ignored. This somewhat loose derivation leaves the formulas in a simple form and gives results in substantial agreement with those obtained in more elaborate discussions by certain foreign authors. It is believed that for direct and curved fire the results can be depended upon to give with a fair degree of accuracy the magnitude and direction of the deviation involved, but it is hoped that this paper may result in the production of some more accurate solution which will still be practicable for application in the field.

Spotting Board

By Captain G. R. Meyer, C. A. C., U. S. Army

This board was devised for use at Battery Jackson, (6-inch rifles, Model 1908) at Fort Kamehameha, H. T. Its purpose is to furnish the battery commander with information as to the longitudinal deviation of his shots. The required data are the range and azimuth of the target from the directing point, and the angular deviation of the splash from the target, as viewed from the secondary station.

As a basis for this work, the plotting board was used to find the deviation in yards corresponding to an angular deviation of one degree observed from the secondary station. This linear deviation will vary with the azimuth and range of the target from the directing point. By assuming any convenient range, and taking successive azimuths at ten-degree intervals, we can tabulate the range deviations corresponding to an angular deviation of one degree. This was done for ranges from 2000 to 11,000 yards, at 500-yard intervals. Using cross-section paper, curves were then plotted representing this relation at any azimuth for the given range. The origin is at the lower left corner; range deviations are plotted as abscissae (scale, 1 inch = 50 yards) and azimuths of the target from the battery are shown as ordinates (scale, 1 inch = 10 degrees).

The following assumptions were made:

1. That the lateral deviation of any shot fired by Case I or Case II is small.
2. The range deviation of a "line shot," within reasonable limits, will be approximately proportional to the angle read from target to splash by the secondary observer, regardless of whether the shot go over or fall short.

The error resulting from these assumptions will be small, and may be neglected in the adjustment of fire.

This chart was mounted on a board 18 inches long, 15 inches wide, with a true edge at the right. A T-square was arranged with its head to the right; its upper edge was graduated from left to right in 5-yard divisions at the horizontal scale of the board. A straight-edge was pivoted at the lower left corner, on a nail driven through the origin of co-ordinates.

Inspection of the chart shows that for any range curve, employing as an argument the azimuth of the target from the battery, we may read from the scale on the T-square the range deviation corresponding to a one-degree azimuth difference of target and splash reported from the secondary station.

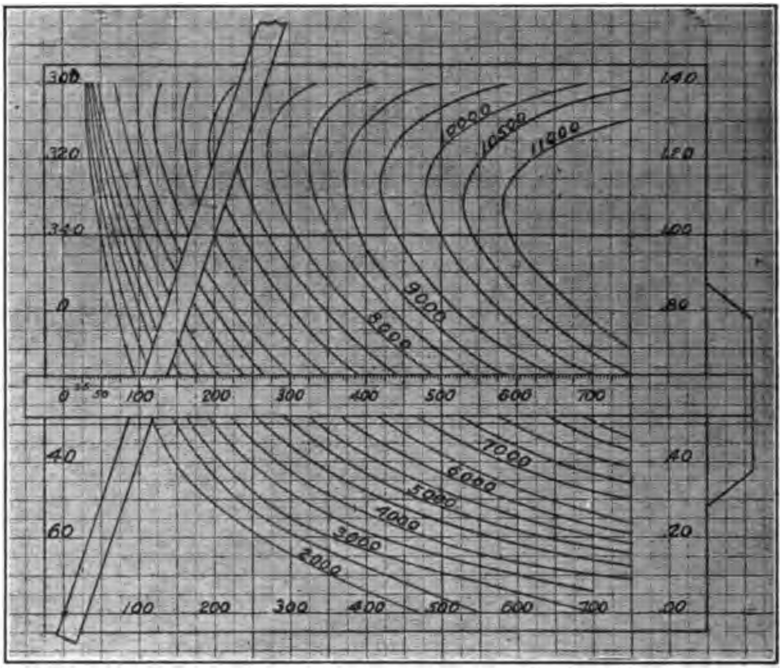

FIG. 1.

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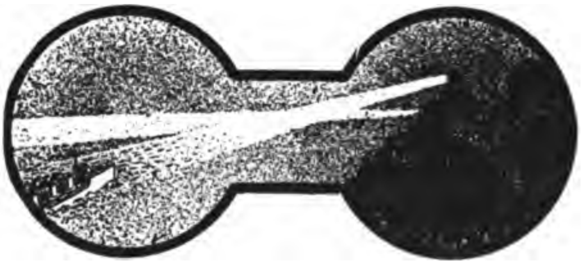
To obtain a rapid means of finding the deviation corresponding to an azimuth difference of more or less than one degree, a scale was laid off vertically from the lower corner of the board, on which each inch represents 0.10 of a degree; a heavy black line was drawn horizontally across the board at the one-degree ordinate. By laying the straight-edge through the origin and the point on this line which corresponds to the range deviation for one degree angular difference, the horizontal intercept at any ordinate representing a fractional degree will give the corresponding proportional range deviation, and its value in yards may be read directly from the graduated edge of the T- square.

In use, the operator hears the range to the set-forward point called by the plotter, and he receives its azimuth from No. 1. He selects the proper curve, interpolating if necessary, and locates the point of proper azimuth (ordinates) by use of the T-square. This point is then projected vertically to the heavy black line, and the straight-edge laid through the latter point and the origin. This process is repeated for each set-forward point. Upon receipt of an observation of a splash from the secondary station, the T-square is slipped along until opposite the proper graduation of the fractional-degree scale on the right edge; the range deviation indicated by the straight-edge is read from the T-square scale, and is called to the range-correction board.

For illustration: the figure shows the setting for an azimuth of 322° and a range of 6500 yards from the battery. The intersection of the 322° line with the 6500-yard range-curve is found, using the T-square if desired. Project this point vertically to the heavy black line, and lay the straight-edge through the origin and this point. If now the secondary reports an angular deviation of 0.63 left, the T-square is set opposite 0.63 on the right hand scale, and on the graduated edge of the T-square is read a range deviation of 110 yards over.



Simpson's Resection

By Captain Stanley H. Simpson, C. A.

At the present time resection is accomplished in a large variety of ways. The methods giving accurate results are long and frequently so complicated that mistakes are easily made and hard to find and correct. This is especially true of the strictly mathematical and graphic means.

Relevement, the French resection method, is probably quicker than most of the mathematical solutions, but is rather difficult to understand and teach. It also requires orientation by computing a terrestrial gisement or from a celestial observation and it is easy to become confused in the final graphic work on account of the multiplicity of lines.

Fig. 2 shows the graphic solution of the new method herein described including the lines needed for the geometrical proof of the method. Figure 3 shows the actual lines that would be used in field work,—merely the lines radiating from P′ toward the known points, the chords of the circle used and the grid axes.

By the use of the mil relationship a much simpler and quicker method of resection may be employed. This method finds its most natural field of usefulness in problems in which the angles are measured in mils. However it is so short and simple that even if the original angles are measured in degrees or grads it pays to change to mils in the problem.

This solution of resection is merely a short cut to plotting on a large scale a number of arcs at whose intersection the sought point is located. Instead of plotting the actual arcs, short-chords of these arcs are plotted but on a scale so large that the chords are practically coincident with the arcs.

The results obtained should ordinarily be within two or three tenths of a meter even where the distances used in the solution are roughly scaled from the map with an accuracy within 20 meters. By computing the distances instead of scaling, the results can be brought to any degree of accuracy necessary.

The method of making the solution is divided up into a series of steps which are given below.

1. Plot the visible known points to a convenient scale (1: 20000), on a sheet of co-ordinate paper if no accurate map or Planchette de Tir is available. With a transit set up at the unknown point read the angles between the lines to the known points. By a graphic method of solving the 3 Pt. problem or by the tracing paper method determinine the approximate co-ordinates of the unknown point. Scale the distances from the approximate point P′ to the known points.

2. From the approximate co-ordinates of the unknown point and the co-ordinates of the known points compute the value of the angles between the rays from the approximate point to the known points. These angles will be slightly different from the angles read with a transit since the approximate co-ordinates of the unknown point are likely to be 20 to 40 meters in error. Compute the distances necessary to move the rays either to the right or left in order to make the computed angles equal to the observed angles. These distances are spoken of as "offsets" and are easily computed after converting the unit of angular measure to mils.

3. Construct a large scale plot around the approximate point, drawing the arcs or short chords of the circles determined by the unknown point and any adjacent pair of known points. The intersection of these arcs or chords will be the true point and its co-ordinates are determined by scaling from the map the increments of x and y between the true point and the approximate point and adding these algebraically to the co-ordinates of the approximate point. The method of constructing the large scale plot can be better understood by examining the problem which is worked out below.

The following problem is given showing the application of this method to a problem where the initial angles are measured in degrees and where there is a great variation in the distances to the known points, so that it may be considered more difficult than those which ordinarily present themselves. However it is evident that the work involved would not take more than a half hour, when four points are considered.

1.—*Given*

Known Points A $\begin{cases} x = 381121 \\ y = 191618 \end{cases}$ C $\begin{cases} x = 383675 \\ y = 190485 \end{cases}$

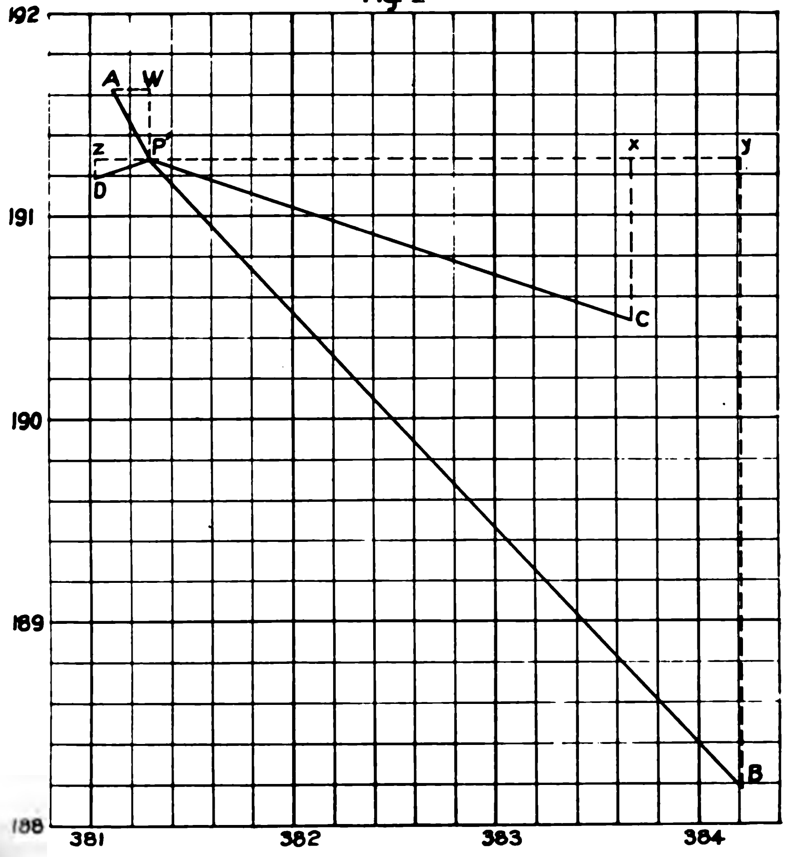
B $\begin{cases} x = 384207 \\ y = 188178 \end{cases}$ D $\begin{cases} x = 381026 \\ y = 191194 \end{cases}$

Angles read with transit
<APC = 137° 30.2′; <CPB = 28° 30.5′; <BPD = 118° 16.7′;
<APD = 75° 42.6′

P′ $\begin{cases} x = 381,300 \\ y = 191,280 \end{cases}$ Approximate Point scaled off map after being roughly determined by tracing apper method.

Distances scaled off map
- P′A 390 meters (approx.)
- P′B 4260 meters (approx.)
- P′C 2510 meters (approx.)
- P′D 290 meters (approx.)

Fig. 1



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2.—

$$\text{Tan} <AP'W = \frac{AW}{P'W} \qquad\qquad \text{Tan}\ BP'Y = \frac{BY}{P'Y}$$

$$\begin{array}{rrrrrrrr} P'_x = & 381{,}300 & A_y = & 191{,}618 & B_x = & 384{,}207 & P'_y = & 191{,}280 \\ -A_x = & 381{,}121 & -P'_y = & 191{,}280 & -P'_x = & 381{,}300 & -B_y = & 188{,}178 \\ \hline AW = & 179 & P'W = & 338 & P'Y = & 2{,}907 & BY = & 3{,}102 \end{array}$$

$$\begin{array}{rl} \log 179 & = 2.25285 \\ -\log 338 & = 2.52892 \\ \hline \log\tan <AP'W & = 9.72393 \end{array} \qquad\qquad \begin{array}{rl} \log 3{,}102 & = 3.49164 \\ -\log 2{,}907 & = 3.46345 \\ \hline \log\tan <BP'Y & = 0.02819 \end{array}$$

$$<AP'W = 27^\circ\ 54'.3 \qquad\qquad \begin{array}{rl} <BP'Y & = 46^\circ\ 51'.5 \\ -\ <CP'X & = 18^\circ\ 30'.5 \\ \hline <BP'C & = 28^\circ\ 21'.0 \end{array}$$

$$\text{Tan} <CP'X = \frac{CX}{P'X}$$

$$<BPC - <BP'C = +9'.5 \text{ or } 2.8 \text{ mils}$$

$$\text{Tan} <DP'Z = \frac{DZ}{P'Z}$$

$$\begin{array}{rrrrrrrr} C_x = & 383675 & P'_y = & 191280 & P'_x = & 381{,}300 & P'_y = & 191{,}280 \\ -P'_x = & 381300 & -C_y = & 190485 & -D_x = & 381{,}026 & D_y = & 191{,}194 \\ \hline P'X = & 2375 & CX = & 795 & P'Z = & 274 & DZ = & 86 \end{array}$$

$$\begin{array}{rl} \log 795 & = 2.90037 \\ -\log 2375 & = 3.37566 \\ \hline \log\tan <CP'X & = 9.52471 \\ <CP'X & = 18^\circ\ 30'.5 \end{array} \qquad\qquad \begin{array}{rl} \log 86 & = 1.93450 \\ -\log 274 & = 2.43775 \\ \hline \log\tan <DP'Z & = 9.49675 \\ <DP'Z & = 17^\circ\ 25'.5 \end{array}$$

$<AP'C = <AP'W + <CP'X + 90^\circ$

$<DP'Z + 90^\circ - <AP'W - <AP'D = 79^\circ\ 31'.2$

$<AP'C = 136^\circ\ 24'.8$

$<APD - <AP'D = -3^\circ\ 48'.6 = 67.7$ mils

$<APC - <AP'C = +1^\circ\ 5'.4 = +19.4$ mils.

$$\begin{aligned} <DP'B &= 360^\circ - <AP'D - <AP'C - <BP'C \\ &= 360^\circ - 79^\circ\ 31'.2 - 136^\circ\ 24'.8 - 28^\circ\ 21'.0 = 115^\circ\ 43' \end{aligned}$$

$<DPB = <DP'B = 118^\circ\ 16.7' - 115^\circ\ 43' = 2^\circ\ 33'.7 = 45.6$ mils.

Mils	Distance	Offset in meters
19.4	P'A = 390 m	7.6 m
19.4	P'C = 2510 m	48.7 m
2.8	P'C = 2510 m	7.0 m
2.8	P'B = 4260 m	11.9 m
67.7	P'A = 390 m	26.4 m
67.7	P'D = 290 m	19.6 m
45.6	P'D = 290 m	13.2 m
45.6	P'B = 4260 m	194.2 m

In making the large scale plot place P′ at the origin of a new set of co-ordinate axes and draw through P′ rays to the known points making the computed angles with the other rays and also with the x and y axes. To plot the chord HG of the circle through the points C, P and B first find the difference between the computed <CP′B = 28° 21′ and the

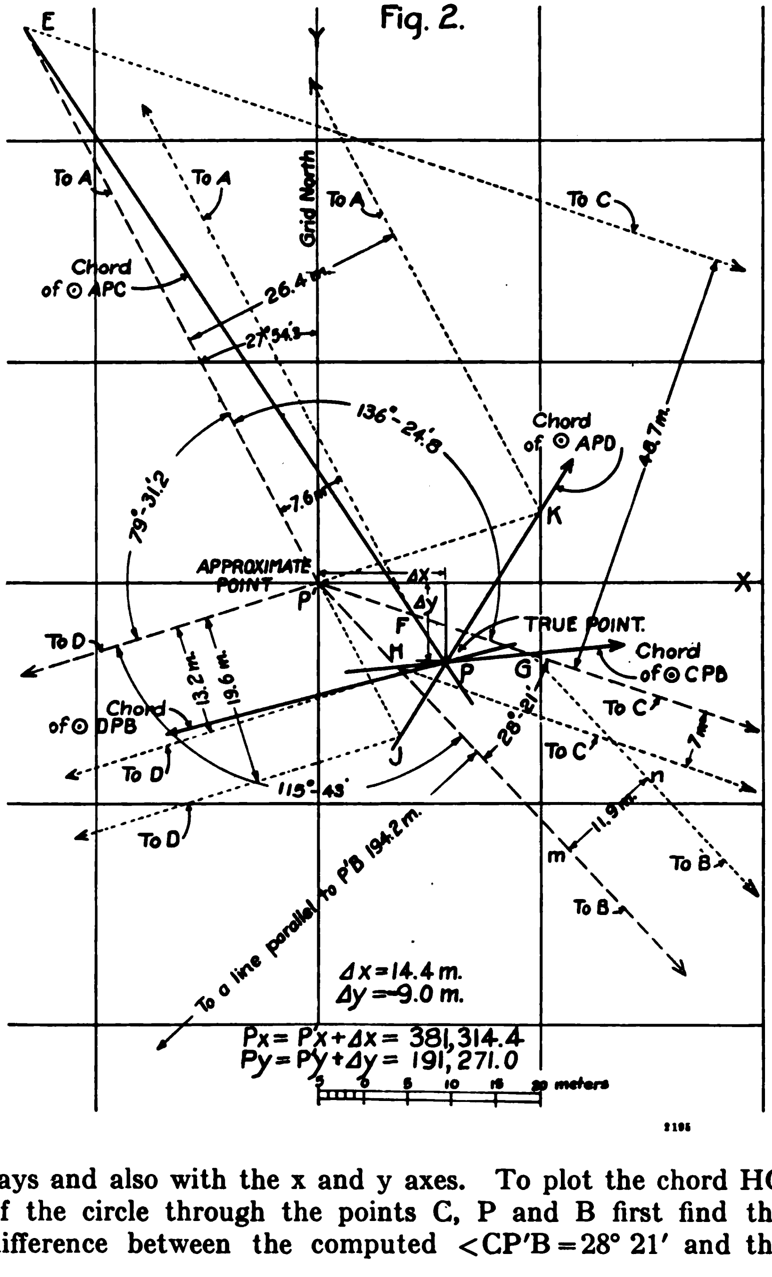
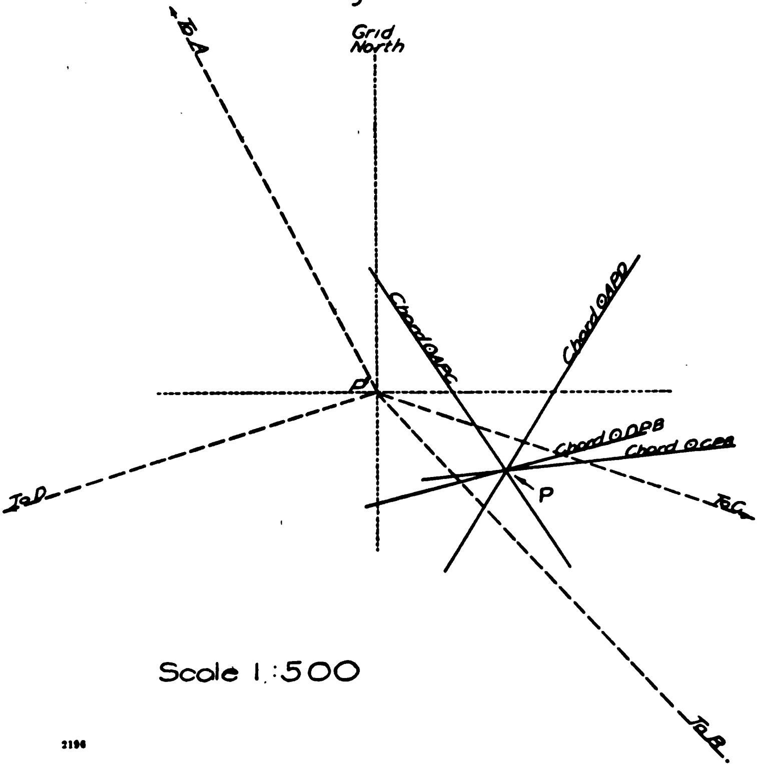


Fig. 2.

observed <CPB = 28° 30′.5. This difference in 9.5′ or 2.8 mils, the <CPB being the greater. Since the observed angle is greater its vertex evidently lies nearer to the points C and B than P¹, the vertex of the computed angle. In other words the segment of the circle in which the angle CPB is inscribed lies between the point P′ and C and B.

Fig. 3



If we were to let the line P′C remain constant and from B draw a line crossing it at G so that the angle BGC = 28° 30′.5 then G is on the same circle as C, P and B. The angular distance between 28° 30′.5 and 28° 21′.0 is 9.5′ or 2.8 mils. B is approximately 4260 meters from P′. Hence if a normal, MN, 11.9 meters long, were erected on P′B the angle MBN would equal 2.8 mils. Since NB for the short distance NG is practically parallel to P′B, BGC = BP′C + P′BN = 28° 21′.0 + 9′.5 = 28° 30′.5, the angle desired. In like manner H is found and the line HG is the chord of the circle desired.

Chords of the circles through APD, DPB and APC are determined in the same manner. They are found to intersect in a point P, however, due to errors in co-ordinates of the known points and to errors in reading angles a small figure of error will be formed very probably. In such a case take the center of the figure as the true point. By then adding the increments, Δx and Δy algebraically to the co-ordinates of the approximate point the co-ordinates of the true point can be determined.

From the large scale plot Δx and Δy in Fig. 2 are scaled and found to be $+14.4$ and -9.0 m. respectively. Adding these values algebraically to the co-ordinates of P′ we obtain the co-ordinates of the true point P.

$$
\begin{aligned}
P'_x + \Delta x &= 381{,}300 + 14.4 = 381{,}314.4 = P_x \\
P'_y + \Delta y &= 191{,}280 - 9.0 = 191{,}271.0 = P_y
\end{aligned}
$$

PROFESSIONAL NOTES

Military Highways[1]

By Logan Waller Page

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In its broadest sense a military highway can be defined as any highway over which equipment, men, or supplies are transported in the conduct of military operations. It may be located to serve a base of supplies, to connect the base with the front line of action, or to distribute supplies behind the firing lines. It is a unit of the transportation system which may involve in its entirety systems of highways, waterways, railways, tramways, and air routes.

In the conduct of modern warfare we now know that the highway plays no small part, because, in addition to its use as an avenue for marching troops, supply wagon trains, cavalry, and artillery, it affords a means of rapid transport that is easily, quickly, and economically constructed to carry heavy units of artillery and accessories, and the moving of large numbers of troops quickly from one part of the field of action to another by motor vehicles, as so often required in the present war. The value of possessing a comprehensive system of military highways becomes at once very apparent when we hear that France was practically saved by her every-ready system of roads and the great number of available motor busses, which quickly conveyed her troops to the point of attack. But in this connection we must not confuse the fact that the system as now completed at the French fighting front was not complete to start with; but it consists in considerable part of extensions to main arteries which were built years ago according to a program having the civil as well as the military needs as a basis of design.

This, in fact, is the only basis upon which any comprehensive system of highways can be designed, and any system not based upon the civil as well as the military problems involved is not only uneconomical but unstrategic, because the present war has thoroughly demonstrated that the organization of all civil as well as military elements is absolutely essential to the rapid production of large supplies and their speedy delivery. In this latter the highways are great factors.

The French road system as it existed has not provided local fighting line roads except as the forces have taken up positions along the highways, and in the location of the military roads in France there is apparent no idea of providing roads to accommodate traffic necessary on a hypothetical battlefield. Maneouvering for strategic advantage in position has considered the existing roads as topographical features. The battlefields have in part been controlled by the roads, rather than the reverse. In the system as built important centres were systematically connected. Through truck roads, on exceedingly good locations, were provided, and the radial system actually existing developed as a result of these primary considerations. Main roads from Paris to all large centres in France furnish Paris with a radial system, and similarly for the lesser cities of France. The development of the local network existed to some degree in the French system in August, 1914, but many miles of local roads have been built behind the fighting lines, not only to replace destroyed roads but to serve local military purposes. Reports from Italy state that four thousand miles of such roads have been built. Our problem, then, is not to develop a local network over small areas, but to provide, first, a series of main arteries between the large centres. In considering this phase of location in a large way it is well to see what is writ large in our national territory. For instance, if we should undertake to develop highways for military or any other purpose on the same scale that France has, there would be 32,000 miles of national roads in the state of Texas, and four times that mileage of intercounty roads; there would be as many main roads in New York and Pennsylvania as there were in Germany, and as many in New England as in Old England, Scotland, and Wales. The development of such a system in detail would be unwarranted by our present economic requirements in times of peace.

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[1] Presented at the Stated Meeting of the Institute held Wednesday, December 19, 1917, by Mr. E. W. James, General Inspector, Office of Public Roads.

Further, the local construction of so close a network of roads would not be warranted over any one area to the exclusion of others. The total battle line on the Western Front, although extending from Switzerland to the Channel, is not so long as the distance from Washington to Boston. The overdevelopment of roads in such an area at the expense of a less development over a much larger area would obviously be a serious error. An enemy would simply go where the system did not exist and there attack.

To adapt the radial system of Germany or the old Roman system of Italy and France to the United States without modification or adjustment to American conditions and distances would be not only uneconomical but a military failure; because America has no one centre to build out from as a base to surrounding foreign countries and because the enemy would certainly not choose a port of landing supported by the best network of highways feeding it.

It appears plain, then that the underlying principle of road location in a large way is to provide, first, the large open net of thorough roads over the entire area of boundary, choosing first those areas most open to attack.

Certain areas are obviously within this class; such as (*a*) the area about Long Island, comprising the New England states and New York; (*b*) the area about Chesapeake Bay, comprising much of New Jersey, Pensylvania, Maryland, Delaware, Virginia, and North Carolina; (*c*) The Pacific Coast area of three states; (*d*) the Mexican border, comprising the southern part of Texas, New Mexico, and Arizona; (*e*) the Great Lakes area, comprising parts of the Lake states; and (*f*) the Gulf area, comprising parts of the southern Gulf and Atlantic states.

In addition to a large network of roads, connecting the centres of population in these areas, there should be through roads leading inland to important centres of manufacture and supply. The number of these necessarily depends on economic conditions. Roads should connect the Pittsburgh, Cincinnati, Detroit, Chicago, Birmingham, and other big industrial districts with the coasts. Such roads have already been found to provide a type of communication much needed, although they would appear on casual thought to be of little value, inasmuch as they parallel main rail lines with a lower and less useful form of travelled way or roadbed.

As the probable demands arising from war conditions on any particular part of the larger highway net cannot be foreseen, for the very simple reason that the actions of an enemy cannot be foretold, we find that the immediate economic and engineering considerations under peace conditions are those that must control in the engineering location in detail of these roads. The selection of any system of highways depends upon the following factors:

(*a*) Population and its distribution, (*b*) location of sources of raw products, (*c*) shipping points for such products, (*d*) location of manufacturing centres, (*e*) the amount of traffic between such centres, (*f*) the character of such traffic. Upon consideration of such factors highways fall into two classes: (*a*) primary and (*b*) secondary. The former are commonly called through roads, and connect a series of centres of population or commerce. These conditions prevail in the military as well as the civil classification, and the selection must be governed accordingly. The primary system must be designed in accordance with the demands of traffic and act as main arteries for the secondary system. The secondary system should be selected as feeders and connections to the primary system. It has been calculated quite accurately that twenty per cent of the highways in America carry eighty per cent of the traffic. Military expediency might bring local roads into the class of primary highways, should any area become a theatre for military operations, and every effort should be made to consider this point in the design of the system. Still the main arteries, the primary system alone, must be relied on back of the lines to carry the bulk of the load up to the zone of action where the secondary and additional roads are improved or built as required.

The design for highway improvements under ordinary conditions is not beyond a reasonable determination after a careful study of the traffic by means of traffic census and knowledge of the country to be served. The density of traffic under peace conditions never can equal that flowing from the demands of war, and any attempt to meet the possible military demands on all roads would result in a breakdown of the highway policy when considered from no other than an economical standpoint. For example, the Bar-le-Duc-Verdun road in France, about 50 miles in length, was forced to carry, during the months of the attack on Verdun, a continuous line of five thousand motor trucks throughout the day and night. Traffic moved in four lines along the highway, the speed of the vehicles varying with the line in which they travelled. Slow-moving horse-drawn vehicles moved along the shoulders, and the trucks moved at about a rate of twelve miles an hour, spaced fifty feet apart, with breaks of one hundred to two hundred feet now and then to allow for high-speed vehicles to shunt into line on passing the usual trains of trucks.

The construction of roads to carry such traffic is only advisable where it appears from the best military information that a similarly congested traffic might be likely to develop in certain very limited areas. For instance, as a part of the general network of roads already described certain sections from important railroad centers in the middle Connecticut Valley, the upper Hudson Valley, and the middle Susquehanna Valley might be constructed to take such traffic as the Bar-le-Duc-Verdun road carried to within easy striking distance of Boston, New York, and Philadelphia. But the mere statement of such a decision is open at once to the reply that to meet the possible needs practically any road in the system might become subject to the unusual conditions.

We are thrown back, then, in our detail location and design very largely upon the same considerations as control highway construction in times of peace.

The military road should therefore be the most economical one, just as in the case of the selection under peace conditions; and, except in cases of emergency, the usual factors will apply. The most economical highway under all conditions is the one which results in the longest life for the amount of money invested and that serves its traffic with ease and safety. It is seen that the demands of traffic are the underlying basis of consideration for the improvement of any road and in turn govern the physical construction through the factors of location, character of improvement, type and width of surfacing, alignment, grade, etc. In general, a military road should be designed to carry traffic without delay or confusion, and with a minimum of effort.

Considerations of engineering location are controlled by the same details as for ordinary highway construction. A slight adjustment of some of our assumptions of design should be made. Grades should not exceed five per cent, except that an emergency maximum up to ten per cent for not more than fifty yards may be allowed. Alignment should have no curves with radius less than two hundred feet, and a vista of not less than three hundred feet. The road foundations and bridge structures should be designed and built to carry at least six thousand pounds forward and eight thousand pounds rearward on a wheel base of 10 x 5 feet. The paved surface should be twenty feet wide and the grade thirty feet wide.

It is seen at once that, with the exception of the last, such requirements are warranted economically in time of peace only on a coarse network of important intercity roads such as that already outlined.

On the large coastwise net and through routes to the interior developments could, of course, continue as traffic demands increased. States having funds could fill in the net with smaller meshes, and the same requirements of design should ultimately apply to these as apply to the ordinary strands of the net, although a lower standard of design might at first be adopted. In many of our states such development already exists.

Much has been said lately of materials and methods of construction. It appears, from the most reliable and first-hand sources of information, that water-bound macadam, telford, V-drains, and stone base are the most effective purely military types of construction. We know that such type is not economical in many localities under circumstances of a piping peace. For this reason the type selected for use in our suggested system may be in accordance with current economic rather than possible military demands. But it is to be remembered that a requirement of maintenance controls under actual fighting conditions. Repairs must be made easily, rapidly, and without in the least interrupting or diverting traffic. The traffic carried by the Bar-le-Duc-Verdun road was astounding in its wear and could not be halted. The question of restoration of road surface called for much ingenuity, and was a matter of extreme expediency. Just what our American higher types of pavement would have suffered is hard to determine, as none of them is found to any great extent in the European zones of activity. Many of them would doubtless stand heavy pounding for a longer time than the macadam, but when rupture came the invariable requirement of immediate repair would force resort to materials and methods capable of rapid and effective application.

The records furnished us so far indicate that water-bound or clay-bound macadam has been generally used by the French and English immediately behind the Western Front. In the accounts, however, little differentiation has been made between the roads actually within the range of shell-fire, in what might be called the battle area, and those to the rear. It seems most likely that American practice can develop an improvement over the water-bound macadam patching in both areas, more especially on the main roads beyond range of shells. The advance that we have made in the last five years in the development of cold patch materials and their use indicates the great possibilities in this direction.

This method can be used on almost any type of wearing surface, from ordinary water-bound macadam to concrete or brick. So if we have any given system of roads constructed to meet the demands of normal traffic in times of peace, these roads may be repaired either with cold patches or water-bound patches if they ever come within the range of hostile artillery.

Roads built or rebuilt as the immediate accessories of an advance must be of materials that consolidate and furnish a travelled way in the least time. Such roads will probably be found in water-bound macadam or gravel. Likewise the repair of these roads, so long as they remain a part of the battle area, will have to continue in part of this type, or perhaps, under some conditions, of cold patch materials.

In this connection it is interesting to note that, when the War Department began the enormous task of building the National Army cantonments, a considerable mileage of camp roads and streets became necessary. The general opinion of those having the matter in charge was quite uniformly in favor of placing a gravel or macadam base at once wherever such materials were available. There were only a few exceptions to this plan in actual construction. The reason for this opinion was obviously that such types could be built most rapidly, and the same day a hundred feet of road was laid it could be used. Further, such construction would serve adequately as a foundation for any topping or surface treatment that might later be considered necessary. In fact, there has been considerable surface treatment, some bituminous macadam, in one or two cases bituminous concrete, and rather generally concrete platforms at warehouses constructed in the several cantonments. The company streets have generally been left as gravel or macadam.

These plans were arrived at independently of any information from the fighting front, as information was not then available. The decisions were reached solely upon a common-sense consideration of the highway problem.

The result of a departure from this general solution of the cantonment road problem is seen in detail in the work being done at Quantico, in Virginia. There it was decided to use concrete. At one time a daily rate of construction of five hundred linear feet of fifteen-foot road was reached by a single mixing plant. This is a rate of about three miles per month. But even this rate was not sufficient to enable completion of the work during the summer and fall. To continue operations into the winter it has become necessary to adopt expensive and unusual methods in order to insure the pavement against freezing and consequent serious damage. The blocks as laid are covered first by a framework of wooden slats; over this is spread a three-ply canvas tarpaulin. A layer of straw and stable refuse is spread on this, and the road remains thus covered about ten days to two weeks. It is necessary, also, to heat both the sand and large aggregate, and this is done by placing through the piles of materials metal cylinders in which fires are built. In addition, the water for gauging the concrete is heated before use, and thus the temperature of the entire mass is kept above the freezing-point until the block is poured and covered with the protecting canvas and straw mat. Of course, these precautions have materially reduced the rate of construction.

Under circumstances like these, which can occur in any latitude north of 33 degrees, and should be confidently expected anywhere north of 36 degres, it is seen at once that the exigencies of rapid construction, immediate serviceability, and simplicity of method and materials throw us back upon the lower rather than the higher types of road surfacing.

Naturally these observations raise the question of costs. It has been stated in a reliable account that from ten to twelve thousand men have been used in one road organization on the British front in Flanders, that four thousand men were at one time on a single mile, and that stone has cost as much as $7.50 per cubic yard. The only statement pertinent is that cost is not considered. Much work is done by hand on the Western front, however, that by American methods might and probably would be done by machinery.

The question of shell holes is interesting, but the destruction from this cause is. according to the best information, much less in general than the layman supposes. Shells that bury themselves in loose earth before exploding burst almost at contact with a hard road surface and expend much of their force in the direction of least reasistance. Consequently, shell holes on the roads are much shallower and smaller than in the fields. Moreover, it is costly business wasting ammunition in indiscriminate shelling of roads. Such destruction as occurs is usually the result of attempts to destroy motor trains or other transports passing over the roads, and is concentrated over a very limited length. Attempts to cut a road by shell fire are usually directed at points where aeroplane photographs indicate cuts or fills. The shelling aims to blow in the cut or blow out the fill. As a matter of fact, there appears to be little shelling of roads merely as such.

For these reasons the large bulk of repair work is the replacing of worn or scattered road metal. There appears to be nothing unusual in the methods used to make these replacements. A roller cannot commonly be used until the congestion of traffic is reduced so that it can be thrown on one-half of the road surface. Then the rollers are put on and the surface thoroughly repaired. Roads that have been gradually brought out of the battle zone by advancing forces are at the earliest moment practically rebuilt, being put into a condition as good as new, according to the reports at hand. If the same series of events occurred in the United States it appears probable that, with the persistence of heavy traffic even after the road has passed beyond shell fire, its reconstruction would have to be rapid and so conducted as to cause a minimum interference with traffic. For this reason it appears most probable that, regardless of original type, such reconstruction would quite generally be of gravel or macadam, at least until the fighting passed entirely out of the region tributary to the road.

We have no data that will lead to a choice of materials with respect to an effort to produce the effect of "camouflage." The French engineers have generally given up attempts to disguise a highway. The reason for this is rather obvious. The enemy locates these roads in the first instance from maps secured in time of peace. He corroborates his evidence by photographs taken from observation balloons or aeroplanes. The reflection of light from the regular surface produces a road in the picture regardless of the color of the surface. The road always appears in the photograph in plain contrast with the surrounding terrain, from which the reflection is irregular. The local attempts at camouflage are now confined to the distribution of branches or brush so as to cast irregular shadows across the surface.

In this connection a detail of importance appears to be the suppression of dust. Although the roads are not gratuitously and promiscuously shelled, they are watched, and if a cloud of rising dust indicates the passage of a support train or ambulance, that could at once becomes a target. The use of light oils or other familiar dust palliatives is of advantage. This also reduces the chance of accident from driving into a fog of dust.

The question of road control is interesting because of the unmistakable demands arising from a military use of the roads. But at the present time the Government has control over only those roads on military reservations, and none but the Secretary of War would have authority to designate other roads of military importance. With respect to the existing present needs the Secretary of War has written as follows:

" * * * to the request * * * that the War Department make known the needs of the military situation in respect to the construction of roads with moneys appropriated by the Federal Post Road Act of July 11, 1916, I have the honor to make the following recommendations:

"(1) Federal aid under the act above mentioned should, in general, be granted only for roads such as can be designated 'through roads'—that is, roads leading from one centre of population or commerce to another. Assistance in building branch roads for automobiles or tourists to visit points of scenic or historical interest does not appear warranted when there is still such a pressing need of a good network of roads in most of the states.

"(2) The War Department recognizes certain areas as more likely to be the theatre of military operations than other parts of the country. Every effort should be made to persuade the state road commissions to complete the network of through roads within these areas, and Federal aid should not be granted unless these roads conform in construction to the needs of the military transportation likely to be used in the zone of the advance.

"The areas in question are:

"(*a*) The area about Long Island, including most of the states of Rhode Island, Maine, New Hampshire, Vermont, Massachusetts, Connecticut and New York.

"(*b*) The area about Chesapeake Bay, including much of the states of New Jersey, Pennsylvania, Maryland, Virginia, North Carolina, and Delaware.

"(*c*) The Pacific Coast area, including California, Oregon, and Washington.

"(*d*) The Mexican border, including the southern part of the states of Texas, New Mexico, Arizona, and California.

"(*e*) The Great Lakes area, including the states of Ohio, Indiana, Michigan, Illinois, and parts of Wisconsin and Minnesota.

"The following requirements as to construction within the areas mentioned are recommended: (1) Roads to have a smooth, hard surface of broken stone or a pavement not less than 20 feet in width and capable of supporting the loads hereafter specified for bridges. ((2) Grades not to exceed 5 per cent, except for short distances (less than 50 yards), where they shall not exceed 10 per cent. (3) Bridges to be of iron or masonry, and of type to support loads of a 6-inch howitzer (3000 pounds on front wheels and 6500 pounds on rear wheels, distance between axles 12 feet, width of wheel track 5 feet) or a 3-ton truck loaded (6000 pounds on front wheels, 8000 pounds on rear wheels, distance between axles about 10 feet, width between wheels, centre to centre, about 5 feet). In hilly country, where road foundations are necessarily in hardpan or rock, the importance of artificial surfacing is less important than the completion of a well-drained road bed joining the roads in the adjacent valleys; and it is therefore recommended that in such cases the completion of an unsurfaced graded road be completed before the requirement as to artificial surface is enforced.

"In general the projects already submitted by state road commissions comply with the first military requirements, as stated above, and it is believed that the Department of Agriculture would meet with little or no opposition in enforcing them as recommended."

In the light of military requirements, the matter of road control is emphasized just as it is by the ordinary economic requirements of the nation at large. It is the one really serious difficulty in our present road situation.

There are small groups of roads in specially created road districts, built with the proceeds of bond issues for which the district is liable. These roads are frequently under the sole charge of bond trustees. In the same county or township there may be other roads under the jurisdiction and control of the county commissioners. Still other roads in the same county may be jointly under the state and county, the latter being directly responsible for maintenance and the former having none but a supervisory authority so long as the county maintains properly. Then there may be a state road across the county over which the state has full control to build and maintain. Finally, there may be a Federal Aid road, and this road may be a section of any one in these previous categories. Over the Federal Aid road once constructed the Government has no control except that if the road be not properly maintained the Government may refuse further aid, at the end of four months, to the particular local unit responsible for the maintenance.

Under such a dispersion of authority it has been in the past, and doubtless will continue in the future to be, almost impossible to secure the systematic continuous construction and maintenance of important roads where the jurisdiction and the control of funds are lodged in so many different bodies. It is quite apparent, from the information that comes to us from Europe, that some centralized control of the roads over a considerable area will become imperative with the occurrence of special military needs. Roads will have to be built and maintained regardless of the local political boundaries, and it appears that any administrative unit less than the state would l to serve adequately the demands that will arise. Such condition, however, is no more pertinent to the possible military uses of highways than to the present economic demand, and the same degree of centralized control is essential in peace as would be required in time of war. The gradual extension and development of this control is therefore warranted in peace as much as it would ever be, for only through such control can the completion of the most necessary roads largely considered be brought about, an advantageous uniformity of construction be attained, and adequate maintenance at all times be assured.

The general conclusion from these observations is that the planning and use of highways for military purposes introduces no new or essentially different principles and only a few altered assumptions. These assumptions are all in the direction of improved and heavier construction in most localities. Some states are already building on designs that are adequate in all respects except perhaps width of roadway and weight of bridges. But many are not doing so.

Some correlated system of roads in certain large areas should be laid out and, regardless of local units and political boundaries, constructed to form a large net of general control roads. A few trunk connections should be made with industrial centres in the interior.

Whether the United States is pursuing a policy in accordance with the demands of modern warfare can best be studied from the standpoint of the administration of the new Federal Aid Road Act which grants Federal aid to the various states. Under this act the states are required to organize a state highway department, submit projects for construction upon which it expects to expend Federal Aid funds, and guarantee that funds for the maintenance of completed projects will be provided by the local units having jurisdiction over the roads constructed.

After one year's operation all of the states have conformed to the requirements of the act and become the units with which the Federal Government cooperates. The several state highway departments are effective organizations for the designation, construction, and maintenance of certain selected roads. Previous to the enactment of this act most of the highly developed and thickly populated states had independent highway departments that had done very effective work. Many of these, such as Massachusetts, New York, Pennsylvania, New Hampshire, Maryland, Connecticut, and California, which have already comprehensive systems of improved roads based upon economical factors are in the groups outlined in the letter of the Secretary of War. Many civic organizations advocating through road construction have been influential in securing some degree of contiguous improvement. The War Department has also designated a few definite roads as essential to military activities, and many of these are being improved as fast as funds and economy will allow.

In those states along the coasts and border a large part of the Federal Aid is actually going on sections of a network that would serve adequately or military purposes. The design and type of construction are in general ccord with the suggestions of the War Department. Of course, all such work is the result of voluntary cooperation. The Federal Government at the present time has no authority to force construction at any point or in any particular manner, and whatever good results are being obtained must fairly be attributed to similarity of engineering judgement, and to the harmonious relations and tactful conduct of affairs between the several governmental units concerned. There are certain directions in which the general program of road construction might be improved. The work among the various states might be more carefully correlated; the designs might be standardized in a few important details, and a program of work devised that will favor the completion of some articulated system of roads. Until such details have been worked out we shall not be able to close the final weak links that abound everywhere in our highway systems, or to provide adequate construction in poor or backward localities. Only when these things are accomplished will our highways at last possess the essential final elements that bring them up to their full effectiveness in time of peace and make them a dependable resource in time of war.

—The Journal of the Franklin Institute.

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The Bombardment of Paris

By Major T. E. Compton

"The progress of artillery is the progress of civilization." This saying of Napoleon, however paradoxical it may have seemed, at times, during the century that has elapsed since it was said, has been proved true by the experiences of the present war, in which artillery development has reached unthought-of proportions, unthought-of at least out of Germany. There, as regards the humane signification of the word, civilization is only a veneer, barely concealing the predatory instincts of the savage, which have, indeed, been openly fostered for forty years by the Imperial Government.

The bombardment of open towns, involving, as a necessary consequence, irreparable injury to monuments of historic interest and great artistic value—such as the cathedral of Rheims—does not seem to be a work of civilization. Rheims Cathedral marked the very highest perfection of pure Christian architecture, undefiled by the Renaissance. To destroy it is barbarous; and this desecration does not unfortunately stand alone to German discredit in the present war, in the course of which the Teuton, by his utter disregard of chivalry, truth, and justice, has disgraced civilization.

But to be civilized has two meanings: to be reclaimed from barbarism is one—to be instructed in the arts and sciences and in social organization is another; and while the Germans have shown, following the teaching of Clausewitz, by carrying force and violence to the most extreme limits, that they believe that war should be barbarous, they, nevertheless, have proved themselves accomplished adepts not only in science, but in philosophy and music as well. If in their conduct towards other nations they are little better than the Huns of Attila, in a material sense and in their learning and their knowledge of the arts of war and peace they are civilized. Moreover, to invent, or produce by perfecting the invention of others, a long-ranged gun, need not necessarily imply a desire to destroy historic monuments and beautiful works of art, and therefore, in the world as it yet is, it is a fair statement that the progress of artillery marks the progress of civilization.

Nations that would be freed from war and from the national and patriotic discipline that war implies, before the time for international arbitration (as a substitute for war) is ripe, only play into the hands of such a Power as Germany, and run a terrible danger. At the present moment, at any rate, war, which has never ceased to accompany every advance in civilization, has reached a state of unprecedented importance both as to the numbers engaged and the instruments of destruction employed. Among the latter is the long-ranged gun.

Just at the time when a radical deputy, M. Abel Ferry, had hit upon the novel idea of confining the aerial bombardment of towns to those within the zone of fire on the Western Front, and had actually put forward this proposition in the Chamber of Deputies, Paris and its suburbs were startled one evening, on the 23rd March, by a short announcement in the evening papers that the origin of the mysterious bombs that had fallen on Paris the day before and on that day was the practice of a long-ranged gun in action behind the German lines. This piece, it was calculated, was posted at 120 kilometres distance, near Saint Gobain (the actual spot is about twelve kilometres N. E. of Saint Gobain, midway between Loan and La Fere).

So great was the astonishment, that this explanation, although official, did not everywhere gain immediate credence, and several other hypotheses were current during the following week. One was, that the projectiles were bombs dropped from aeroplanes that had climbed to such a height in the sky as to be invisible. Another, that bombs were carried over Paris by small balloons and detached at the required moment by a clockwork mechanism. The wind being in the right direction, north-east, this latter theory was much favored by amateur scientists, who believed the balloons to be directed by hertzian waves, in a similar manner as certain vessels that the Germans put in movement on the sea without crews, which craft had been discovered and destroyed by the British Navy off Ostend. The partisans of this hypothesis remarked that these bombs made little or no noise in the air preliminary to falling, whereas projectiles fired from heavy guns could invariably be heard approaching.

But the professionals, such as M. Painlévé (late Premier, and President of the Academy of Sciences) and M. Nordmann, for example, accepted the official statement from the first, the only question in doubt being whether the shell was of an ordinary type. It was thought by some that an invention had been applied to the shell by which a layer of warm gas was developed and kept in front of it during its flight, thus increasing its remaining velocity and range. Such an artifice has actually been invented by a Russian, M. Chilowski, but apparently it had not been as yet taken over by the French Government. Probably it will be now, if there is anything in it; and M. Charles Nordmann, in an article published on April 15th in the *Revue des Deux Mondes*, expresses his opinion that it was a great pity that the Censor permitted any reference to the invention. He states that mention of it has already appeared in the German Press, and that it is quite possible that the enemy will now perfect and apply the idea.

Artillery experts, and those versed in ballistics, agree that the shell in the present case has no such assistance. As to making little or no noise in the air before falling, this due to its steep angle of descent. If, as is thought probable, the gun is fired with an elevation of 55°, and if, as is said to be the case, the angle of descent in a trajectory is always greater than the angle of elevation, it will be easily understood why there is little or no noise in the air before the projectile strikes the earth or buildings in Paris. As it ascends in its flight to a height of nearly twenty miles, its striking force, in falling, must be terrific. It falls rather than flies.

Of the more far-fetched theories aired in the Press, it was seriously suggested that the gun was fired from a Zeppelin, and that the projectile was a double shell, in which the outer case was really another gun projecting the inner shell by a discharge of powder ignited by a time fuze in the course of its flight. Another equally absurd, but more imprudent, hypothesis regarding the gun and shell was expressed by two young women (a modiste and a mannequin by trade) in a cafe publicly and quite possibly objectionably, that the gun was much nearer than 120 kilometers, and that the Germans could bombard Paris as much as and whenever they pleased. For not keeping this theory to themselves, they had each to undergo twenty-one days' imprisonment, which, it is to be hoped, will make them more careful in future. Such is war!

The shell is of steel having a thickness of 3.937 inches, the calibre (of the gun) being 210 milimeters, and not 240, as it was for some time supposed. The base is flat, into which base the fuze is screwed. The front of the shell is covered with sheet iron, according to M. Nordmann, and this front part is so long (and pointed) that its length is almost half that of the whole projectile, a form that had evidently been carefully studied with the view of lessening the effect of the resistance of the air. The cylindrical part is grooved to fit the grooves of the gun. As to the results of the bombardment, with the exception of the church, where a considerable part of the congregation suffered from the fall of the roof, a supporting pillar being cut through, and the case where a main gas pipe was cut through in a street, causing a fire, the effects of these shells have been small, and the reports in the German newspapers pure invention. As to panic, it was the indifference of the public to the bombardment that for a long time troubled the authorities; and even now, the receipts at the principal Paris theatres, both for matinee and evening performances, are very good. A list published the other day, for a Saturday and Sunday in April, averaged about £300 per performance. The shell being comparatively small and very thick the explosion is not so very formidable, but on account of its thickness, pointed front, and the terrific force with which it falls, it can, of course, do considerable damage whenever it strikes masonry, and here and there locally cause some loss of life, although often for days there are no victims. Some poor old fellows playing bowls—a favorite amusement in and around Paris—on earthen courts, had six or seven of their number knocked out on one occasion, and a remarkable escape of a little girl was reported, who was blown by the air blast into a sewer that the shell had opened. She was only slightly hurt and was able to walk along the sewer till she came to a ladder, up which she climbed. Her cries attracted the attention of a butcher-boy, who had the satisfaction of lifting up a slab and releasing her. In the course of many months, if these long-ranged guns cannot be mastered by the French artillery and aviators, their shells will probably do an appreciable amount of damage to the architecture of Paris, without obtaining any military advantage whatever, for the evacuating of school children and the voluntary exodus of a large part of the inhabitants who are not obliged to remain in the capital, cause no military inconvenience to the French and gain nothing for the enemy. The morale of the remaining population is totally unaffected.

Whatever the actual pattern that these guns make at this range, which must vary as they are used, for their life is very short, it is quite likely that the enemy vary slightly the direction and possibly also the elevation during the daily practice. Although this takes place usually by daylight, it has been carried out, at least once, by night. As the flash of the discharge is more easily observed at night, it was thought for some time that these guns would never be fired at night for fear of disclosing their exact position. This has been known approximately from the first day they came into action; but their actual emplacement is concealed by trees, smoke, and camouflage, making it difficult to silence them by direct hits. One has been reported out of action by explosion, but whether this was caused by a French shell or by an imperfection in the gun itself is uncertain.

The *Journal des Débats* of the 14th April published some interesting details with regard to the actual position of the guns, furnished by the correspondent on the French Front of the Havas Agency. Crépy-en-Laonnois is the place, on the line of railway between Laon and La Fere. The battery consists of three guns, of which two were for the bombardment of Paris, the third being in reserve. The site of this battery is in the horseshoe holllow of the *Mont de Joie* about one mile to the north-west of Crépy. This hill is about 600 feet high (above sea-level), and the opening of the horseshoe is towards the town of Crépy-en-Laonnois, the guns being placed on the reverse slopes and in plan on the points of a triangle about a thousand yards apart. The gun that burst was on the apex farthest from Crépy. These pieces are on concrete fixed platforms. They were brought up to their positions by the Laon-La Fere railway, from which a branch line was specially constructed. It was this little branch line that gave away their situation.

In the month of October, 1917, aerial photographs disclosed the existence of this branch line, the development of which was closely followed, although the object of it was, of course, unknown and unsuspected. During February, the Germans began to resent strongly the curiosity manifested by the French air service, and proceeded to establish several anti-aircraft batteries all round the Mont de Joie, which precaution drew the attention of our Allies still more to this particular locality. Therefore, when it was known that projectiles, which from their great thickness appeared to be shells, had fallen in a mysterious way on Paris, the object of the branch railway and anti-aircraft batteries at Crépy-en-Laonnois became manifest. The secret was out, and measures were at once taken to encounter and frustrate, if possible, by the fire of the heaviest guns, the enemy's design.

This, however, has proved to be no easy matter. As already remarked, it is possible that the cannon reported to have burst, was really struck by a 320 or 370 French shell. But besides the anti-aircraft batteries, observation was rendered particularly difficult by an intense emission of smoke, by some means or other, just before a gun was fired which formed an artificial cloud impenetrable to the view. Also, by the same electrical apparatus, a number of other heavy guns are fired at the same moment as a long-ranged cannon, in order to confuse the reports and prevent location by sound. Nevertheless, the fire of such monster guns as those of 320 and 370 millimeters caliber, directed on the locality at ranges of twenty miles or so, must interfere to some extent with the practice, and possibly the days when no bombardment is experienced (there were two running at the beginning of the third week in April) are those following damage done either to a gun or to the gun detachments. The life of the guns must, however, be taken into account, and if this is, as it has been stated, only 65 or 70 rounds, a good deal of work must be constantly going on in connection with their mounting and dismounting. It is probable, also, that new concrete platforms have been made in other positions. From experiences up to the time of writing (end of April), it seems not improbable that the more or less continuous bombardment of Paris must be expected, and certainly ought to be prepared for, for many months to come.

With regard to the scientific side of the question and the character of gun employed, experts are agreed that with an elevation of 45°, or 55°, and sufficient initial velocity for the projection of the shell through the denser layers of air near the earth into the rarefied atmosphere of ten to twenty miles above—where resistance to the flight of the projectile is practically *nil*—there is nothing very extraordinary in a range of 75 miles, and that there is no necessity for assuming any new invention either in the manufacture of the gun or of the shell.

No doubt the composition of the powder, which is an important part of the problem, as also the nature of the metal; which must be tough and elastic enough to withstand a higher generation of gas than has hitherto been the rule, have been matters of special study; and great length has been given to the barrel in order to distribute the pressure, the powder being so prepared, in discs, that it will continue to burn for exactly the time taken by the shell to pass through the barrel and leave the muzzle. Moreover, to facilitate rapid ascension, the shell is grooved in the steel of the exterior surface (instead of having the usual band of copper), which idea, for a long time under consideration in France, is thought to make the shell turn more quickly and thus increase its range.

But all this is merely a matter of perfecting existing inventions, at which the Germans excel, and for experiment, for which there are many favorable localities in Prussia. Why the long-ranged gun has been brought into practical use by the Germans, before its adoption by other nations, is simply because they had a definite object in view, which was considered worth the trouble of producing it. A gun firing at a range of seventy-five miles requires a big target. With an elevation of 55° it would be impossible to make sure of hitting anything of military importance, such as a fort, or a railway station. But directly an entrenched line had been established in France from the North Sea to the Swiss frontier, an excellent target, six to seven miles in diameter, presented itself to the minds of German artillery experts. With the flanks of their front secured by impassable obstacles, the bombardment of Paris from a concealed position behind their lines was quite possible, if their Government considered the expense and trouble of making the guns would be compensated by the effect produced, or likely to be produced, in the French capital. This was the one point of importance. To the Allies a long-ranged gun did not seem to be worth the trouble of manufacture, or it would have been taken in hand before. Now, not to be outdone by the Teuton, it has been announced in Parliament that the necessary measures have been taken for the construction of a similar (British) gun with a range of eighty miles.

Hitherto, high-velocity guns have never been fired (except by the Germans, perhaps, on Dunkirk) with high elevations. Howitzers with low velocity have always been employed. The trajectory of these 210 millimeter (8.267 inches) guns have been given recently by the German General Rohne, in the *Vossiche Zeitung*, as measuring 125 miles, with a culminating point of 19 miles.

M. Nordmann considers it probable that a tube of 210 mm. caliber is inserted into a cannon of 380 caliber greatly strengthened at the breech in order to withstand an explosion producing initial velocity of about 4600 feet a second (1400 meters), which, in his opinion, is sufficient, although 1500 meters (4921 feet) has been suggested by other authorities.

General Chappel, writing in *La France Militaire*, takes the same view: "The discovery that the very fantastic law of resistance, particularly severe within the limits of the initial velocity utilized for our pre-war guns, lessened in severity above 500 meters (i.v.), and that this amelioration accentuated more and more at the higher velocities; this discovery was the key to the 75-mile gun, inasmuch as it showed constructors that it would be possible to project a shell 100 kilometers with an initial velocity *of* 1200 *to* 1400 *meters*, although the law of resistance, relative to our pre-war guns, would have required an initial velocity of 1800 to 2000 meters, for which we have probably still a long time to wait. Even to produce the present gun, which it may be assumed is at once massive and eminently fragile, long and costly experiments have been necessary, as the time taken to bring it into action proves."

In General Chappel's opinion, the Germans at once set to work on these guns, as soon as their entrenched line was established in France in 1914, and consequently he assumes three and a half years as the time spent in experiment and construction. But this is, of course, only a conjecture, based on the bombarding of the capital by Taubes in the first year of the war. Our gun, which it is stated is about to be taken in hand, may quite likely be produced in a third of the time. The chief point for consideration is, what is the incentive for rapid manufacture? What is it going to fire at when ready? This the authorities will keep secret, and a great deal depends on the pattern the gun makes when constructed. Such a large target as Paris, however, is by no means necessary. Berlin would be quite large enough, although it is almost exactly half the size.

The latest report, at the time of writing, as to the state of the guns at Crépy-en-Laonnois, which may be taken as official, is to the effect that only one gun is now (27th April) serviceable. The gun that burst has been dismounted and removed, but not replaced, and the third gun has been hit by a French shell, which also decimated the section serving it. A shell from Crépy-en-Laonnois exploded in a Paris factory, but fortunately at the time when all the workpeople had gone to their *déjeuner*, so no one was hurt.

The practice of this gun by night seems to be becoming more frequent. If ten heavy guns are fired together with it, it may be as difficult to distinguish the flash of this particular gun by night as it is to locate it by the report of its discharge by day.

Let us hope that the perseverence of the French gunner may be soon rewarded by the silencing of the last remaining piece of the monster battery of Crépy-en-Laonnois. —*The United Service Magazine.*

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The "Panzerkraftwagen": A German Version of the Tank

The much heralded "Panzerkraftwagen," or German tank, made its debut in fair numbers in the great attack of March 21st last. One of these tanks slipped into a stone quarry and turned over on its side, and a subsequent advance by French troops placed this German machine well within Allied lines where it could be studied at leisure.

The German version of the tank is a ponderous affair, quite in keeping with the "kolossal" tendencies of the Teutons. It weighs 45 tons, and carries a crew of 18. In general appearance it follows the French rather than the English design of tank, but is far larger than anything yet attempted by the Allies with the exception of the American steam-driven tanks which, at this writing, have not yet been in action.

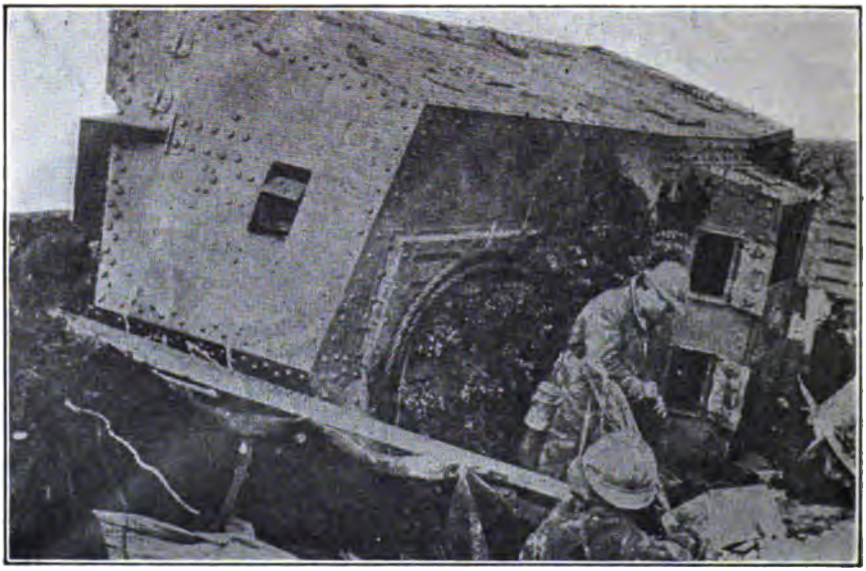

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FIG. 1

REAR VIEW OF THE GERMAN TANK, SHOWING THE COIL OF CABLE CARRIED ON THE ROOF

Following the practice of the French and British tank crews, the Germans have named each of the Panzerkraftwagen. In the case of the captured tank it bears the name "Elfriede," and carries on all sides the characteristic Maltese cross of the German air service. Its armor varies from 1.2 inches for the front plates to .64 inch on the sides and .8 inch at the rear. The steel employed must be applied in considerable thickness because of the evident lack of steel in Germany, and that in turn makes for a cumbersome, if not inefficient, tank.

As for armament, one 47 mm. or 1.85-inch rapid-fire cannon is mounted for direct fire ahead, and six machine guns mounted in pairs are placed at the sides and the rear. The 18 men of the crew have none too much room

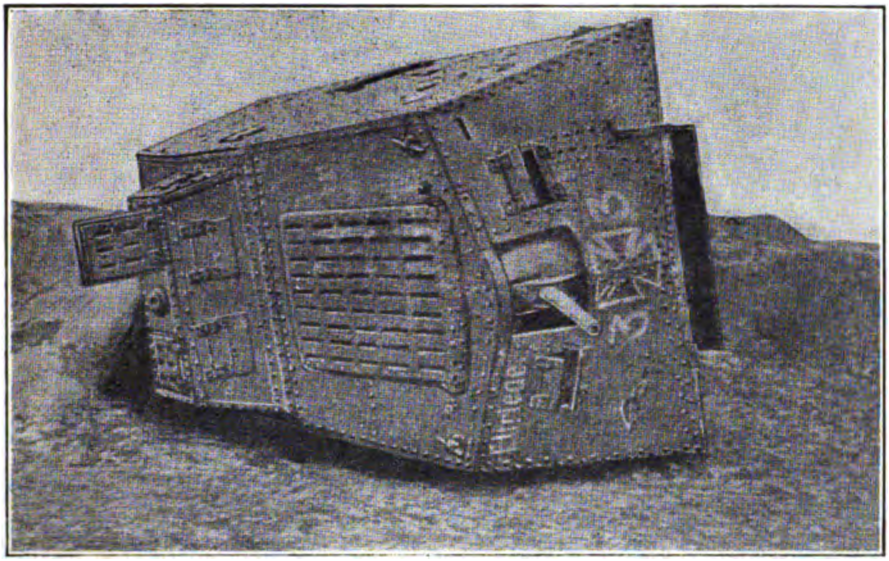

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FIG. 2
FRONT VIEW OF THE GERMAN TANK WITH ITS RAPID-FIRING CANNON, SHOWING CONNING TOWER FOR DRIVER

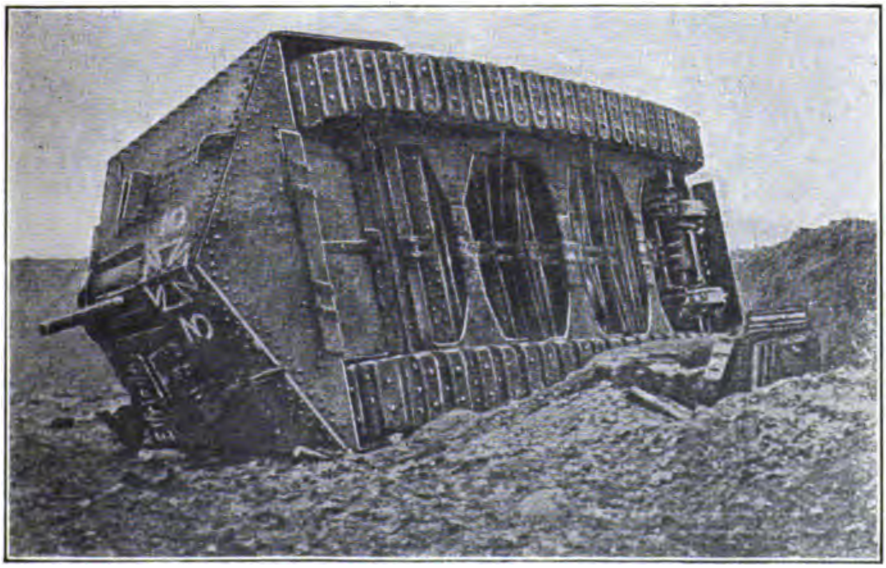

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FIG. 3
UNDER SIDE OF THE PANZERKRAFTWAGEN, GIVING SOME IDEA OF THE ARRANGEMENT OF THE CATERPILLAR BELTS

in this 23-foot tank, and the conditions during actual combat are certainly not unlike the proverbial sardines in a box. The conning tower, in which the driver sits, is entered from above and has hinged side-shutters; but it is reported that observations even at moderate range, is difficult owing to structural defects. The crew can get in or out of the steel box by means of two doors on either side. Every inch of space within the tank is utilized to the utmost; in fact, folding chairs are mounted on the inside of the doors and ropes are hanging from the ceiling in order to provide "straps" for the crew after the fashion of a crowded street car.

All in all, the Panzerkraftwagen, aside from an inclosed gear box which reduces the possibility of the gears getting clogged with mud and dirt, presents no great improvement over French and British tanks which have fallen into the hands of the Germans. If anything, it is merely more cumbersome through lack of proper materials, and therefore a poorer fighter.

—*Scientific American.*

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BOOK REVIEWS

A Dictionary of Military Terms. By Edward S. Farrow. New York: Thomas Y. Crowell Company. 682 pp. 7" x 4¾". Price, $2.50.

This new work although only of pocket size contains a list of over 300 abbreviations in general use, a comprehensive lexicon of military terms with definitions and a series of plates showing insignia and distinguishing marks of various arms of the service. It supplements the general lexicon giving words and definitions upon which the latter is silent.

The author is admirably equipped for this great task. In 1880 he was appointed Instructor of Tactics at West Point and while there compiled Farrow's "Military Encyclopedia" which took its place as a standard work. It will be very useful to all military schools, military writers, army officers, students, editors, librarians and careful readers.

Manual of Local Defense. By Major Henry A. Bellows. New York: The Macmillan Company. 5¾"x 4½". 145 pp. 10 il. 1918. Price, $1.00.

This book is not on a subject that is of interest to our National or Regular Army at the present time. The greater part is devoted to the subject of organizing and drilling Home Guard Units—Much is made of the handling of the crowd before it reaches the "mob" stage. As the author points out, the regular troops do not come in during this early stage of local disturbance, so the officer in our permanent army can gain more on this subject from James A. Moss' "Officers' Manual" or "Riot Duty." However, to those entering into the home guard end of military service—the information compiled by Major Bellows should be of much value.

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Journal of the United States Artillery

September-December,
—1918—

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JOURNAL OF THE UNITED STATES ARTILLERY

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JOURNAL UNITED STATES ARTILLERY

PRIZE ESSAY COMPETITION

1918

The JOURNAL U. S. ARTILLERY announces the following for its annual competition.

PRIZES

One hundred and fifty dollars will be given for the best essay and one hundred dollars for the second best essay submitted on any coast defense subjects.

CONDITIONS OF THE COMPETITION

(a) Competition will be open to all readers of the JOURNAL.

(b) Award will be made by a committee of award, consisting of three persons, to be nominated by the Coast Artillery School Board. If no essay submitted seems to the committee worthy of a prize, none will be awarded. Honorable mention may be made of any essay submitted which seems to the committee worthy thereof, but to which a prize is not awarded.

(c) All essays entered in competition will become the property of the JOURNAL OF THE UNITED STATES ARTILLERY. These will be published, if approved by the Coast Artillery School Board.

(d) Copy must be typewritten, with lines double spaced, on one side of the paper only, and must be submitted in triplicate. If illustrations are included, one of the three copies thereof must be in the form of drawings, tracings, or photographs (not blue-prints nor brown-prints).

(e) Copy must contain nothing to indicate its authorship, must be signed with a *nom de plume*, and must be accompanied by a sealed envelope containing this *nom de plume* and the name of the writer. This envelope will remain in the hands of the Editor of the JOURNAL and, after award has been made by the Committee, will be opened in the presence of the Coast Artillery School Board.

(f) Copy must be received on, or before, December 31, 1918. It must be addressed JOURNAL U. S. ARTILLERY and the envelope must bear the notation, "Essay Competition."

NOTICE

The JOURNAL U. S. ARTILLERY desires to receive from its readers. titles of subjects which they consider would be of interest to the service, A title will be published (either on the "Prize Essay" announcement page or immediately following "Short Notes") until a paper on that subject has been received.

Frontispiece

2700

Photograph from Underwood & Underwood.

A BATTERY OF BRITISH HEAVY ARTILLERY ON THE WESTERN FRONT

JOURNAL
OF THE
UNITED STATES ARTILLERY

VOL. 49, No. 4. SEPTEMBER-DECEMBER, 1918 WHOLE No. 150

The Artillery Council of 1887

By Major General J. P. Sanger, U. S. A.

The artillery council represented the first concerted effort by artillery officers to effect a reorganization of the artillery.

This had been a subject of great importance to the artillery since the year 1832, when the Ordnance Department made its first appearance, and deprived the artillery of many of its officers and duties. In fact, it was organized directly from the artillery.

In the vain hope of redressing the wrong thus inflicted upon the artillery, several attempts were made by artillery officers toward its reorganization and rehabilitation, but as it was without influential friends, and with no one in Washington to represent it, and, moreover, was opposed by a watchful and relentless enemy, all efforts failed, and at the beginning of the year 1887 it was in a worse condition, if possible, than it had ever been.

Just at this time, however, two distinguished officers appeared to represent and advocate its cause and to infuse new life and hope into the organization. In the month of April, Maj. Gen. J. M. Schofield assumed command of the Division of the Atlantic, in which four of the five regiments of Artillery were stationed, and in which he took the deepest interest, as already explained in the Artillery Journal of May-August, 1918. The other champion was Professor Peter S. Michie of the Military Academy, who published an article entitled "The Personnel of Sea Coast Defense" in the March Journal of the Military Service Institution.

Coming from such a scientific, disinterested and prominent critic as Professor Michie, the article attracted wide attention, and aroused the artillery as probably no other agency could have done at that time, and Gen. Schofield decided to use it as a means toward healthful agitation and a public expression of opinion by the artillery on the subject of its reorganization. With this end in view the following circular letter was mailed to all artillery post and battery commanders and to all detached artillery officers:

Governor's Island, N. Y., February 25, 1887.

Sir:

A movement is contemplated to rehabilitate the artillery in its scientific duties, and to place it on a footing with the artillery of other armies.

This movement had its origin outside of the artillery, and will be pushed by those whose sole object is the right organization and administration of the army and its efficiency as a whole.

It is suggested that Professor Michie's paper, which appears to-day, can be made the basis of co-operation by the artillery, and it is earnestly requested that you will take advantage of this opportunity to enlighten the public as to the actual condition of the artillery and how it has been degraded in all its branches. To urge upon Congress a reorganization which will revive and equalize promotion and restore those ancient rights and duties, upon the exercise of which not only the efficiency of the artillery, but the development of a practical system of artillery material depends.

All communications, anonymous or otherwise, addressed to me will, through the kindness of a friend of the artillery, be published in a New York daily of prominence.

Very respectfully,
Your obedient servant,
J. P. SANGER,
Bvt. Major, U. S. A.

Many articles were published in the papers and many letters received in answer to this circular, of which more later.

Professor Michie's criticism of the artillery personnel, the sea coast forts, and their armament may be read by anyone having access to the files of the Journal of the Military Service Institution.

There was no question as to the facts stated by him, but his inference that most of the evils shown to exist could be attributed to the regimental organization was concurred in by but few of the older officers, who were aware of many causes, far more injurious to the artillery, than the character of the organization. Professor Michie made the too common mistake of confounding the organization of the artillery with its deplorable administration by the War Department, which as he could not very well criticise, he charged to the regiments and their colonels. For similar reasons, probably, he did not allude to the abolishment of the Department of Artillery at West Point, and to the organization of the Ordnance Department from the artillery and the assumption of many of its duties, but showed that he clearly comprehended the inevitable results, as the following quotation shows:

"The stagnation of the artillery is also intensified by the persistent neglect to which it has been subjected for so many years. Instances are exceedingly rare where opportunities have been granted to artillery officers for professional instruction and improvement. To learn anything about modern gun construction; to be present and take part in the testing and proving of guns; to be admitted into the professional secrets of harbor defense; in short, to have any part or parcel in matters immediately concerning their own profession, is contrary to the practice that has too long prevailed in the Army. Rigidly excluded from all participation during the period of preparation and construction, they will nevertheless be held strictly accountable for whatever defects may be developed after the system is given into their custody. If this neglect of the artillery affected only the professional fortunes of its personnel, it might, perhaps, be dismissed in a word and charged against the 'ingratitude of republics.' But its consequences are more serious. It threatens the safety of a great country and endangers the interests of a great people. It has shorn the artillery of its strength, whose restoration, absolutely essential for the security of our coast and frontier, can only come with time. With officers unskilled, gun detachments untrained, and weak garrisons at but a few points on the coast and none on the frontier, the fate of Alexandria will be ours at every point attacked by an enemy, unless the present evils be first eradicated and then opportunity for the development of a new and vigorous life be provided for."

The great length of this narrative will not admit of quotations from all that was written and published as the result of Professor Michie's critique. It was very freely and fully discussed, with many grateful acknowledgments of his efforts, and the benefits which it was hoped would result. Among the letters received by me were two from the late Major General H. J. Hunt, the most experienced and distinguished artillery officer our army has ever had. In reply to the circular and a personal note which accompanied it, he wrote, under date of March 25, 1887: "I have been working on this subject for forty years, nearly, and I have never seen the time when the artillery could agree upon anything............ Why do you hope for better things now? In 1851 a bill was brought into the Senate to make the artillery a corps and give it a chief. We had the Senate Committee; it interfered with no one directly, but, as the Chief of Ordnance said, 'it looks innocent but if passed the Ordnance can't live five years'—so they killed it; a few Engineers helped us; the artillery wouldn't unite on it. In 1861-2, when McClellan was all-powerful, the artillery might have been formed into a corps, absorbing the Ordnance. He prepared a bill, providing for 100 batteries and companies, etc..... Some artillery officers, by trying a little legislation on their own hook, managed to kill it; they wouldn't unite. At the close of the war another effort was made in the general reorganization; they wouldn't unite. In 1878-9 another attempt, a dead set, was made to get a chief; a little over one-half joined in it; the old objections were on hand; they wouldn't unite. Why do you think they will do so now? You will, I fear, think me lukewarm or opposed; not so. I have the subject at heart and the time has come when we ought to have a good artillery even if the present one is cut up, root and branch, and the ordnance converted..... The artillery is as badly off, and worse than it was in 1849. The ordnance have got all our duties. I see now but one chance, and that the artillery won't see, and I can't propose it. You want a chief, a chief, a chief, any chief, so it is a chief, no matter who...... I would like to see the chief of ordnance made ex-officio chief of artillery. I don't propose this. I doubt greatly if General B........ would accept it."

Referring to Professor Michie's criticisms, he wrote: "I am glad to see that from whatever motive a member of the Academic staff of West Point has a kind word to say for us; but let him try to restore the Artillery Department at the Academy—that will bring up the best discussion."

General Hunt made other suggestions in his letter, but the foregoing are a sufficient expression of his views on the subject of reorganization. It is quite apparent that his past experience had made him skeptical as to united action, but if that were possible then he believed in the formation of a corps, absorbing or embracing the ordnance, with a chief at the head, but above all a chief.

General Hunt's letter did not deal extensively with Professor Michie's views of the artillery which were passed with a bare reference, as already quoted. But in a letter to the Army and Navy Journal of March 5, 1887 he amplified as follows: "There must be other reasons, then, for the emasculated condition he describes, granting it to be approximately true, and they may be enumerated as follows:

"The Military Academy is and has for over 35 years been in no small degree repsonsible for all the Professor complains of. Jefferson Davis, a graduate of the infantry, as Secretary of War, broke up at the Academy the 'Department of Artillery,' probably at the instigation of his mentor, Maynadier, of the Ordnance, and instituted in its place the 'Department of Ordnance and Gunnery.' Since that time the Academy has taught all its graduates, that the artillery duties which give character and standing to the artillery of other armies, appertain wholly to an anomaly called the Ordnance Department. A cadet leaves West Point with the impression, so far as all there taught him of artillery is concerned, that the horizon of duty for an artillery officer is provided by the monotonous 'By detail load, 2-3-4,' or 'Heave,' interspersed at intervals, years apart, by field battery, drill, or parade; never having seen an artillery soldier's unifrom, except as a cure for the nakedness of a day laborer or a post scavenger. The writer was once shocked beyond measure at hearing a distinguished artillerist say: 'The Military Academy, instead of being an alma mater to us (meaning the artillery) was a stepmother, and a harsh and brutal one at that; for she not only wronged and persecuted us, but taught our own children to do the same.' He has lived long enough to sadly realize the truth of the remark—an artillery officer's duty is simply that of a gun pointer and a drill sergeant, as taught at the Academy; all else appertains to the Ordnance Department.

"The rise of this anomaly from the artillery, due to the desire of certain of its Coburgers, with personal and political influence to so arrange that they should monopolize the flesh pots of Egypt, its lapse and subsequent resurrection as a noncombatant department of the Army with defined civil duties 'to consist of skilled armourers, wheelwrights, carriage-makers, blacksmiths and laborers,' its firm establishment at the seat of government, and at various arsenals, under the claim that 'military control of artisan labor would lead to troublesome consequences,' its subsequent accession to full-fledged soldiers, the endeavor to place them in seacoast forts, and as light artillery soldiers under ordnance officers in military expeditions, the gradual assumption of all professional duty of artillerists save the active command of so-called artillery troops, the destruction of the provisions of the Army Regulations of 1821, which relegated the ordnance to their depots and arsenals and forbade their appearance at any headquarters, the orders of the War Department of 1864 transferring artillery duties to the ordnance, and, finally, the orders of 1877 requiring all artillery commanders to report to the Chief of Ordnance, on his blanks, of every shot fired in instruction, practice, or even in action, are facts too well known to be dilated upon here, and have accomplished much of their object as well-laid schemes to render the present organization of the artillery supernumerary, and allow the Coburgers to swallow the shadow as they have the substance, relegating the 'regiments' to other arms, or to be mustered out—in the fullness of time—as an economical Congress may see fit. All this has been, and is, an active factor to be counted in considering the present state of the artillery regiments.

"The neglect of the artillery by the War Department and the Headquarters of the Army during and since the Civil War has been another factor not noticed by the Professor that has tended to paralyze progress in a professional direction."

As already stated, many articles were published, and many leters received on the subject of reorganization; but the only *practical* suggestion came from the Artillery School, Fort Monroe, where meetings were held of all the officers there stationed, and finally an advisory committee was appointed, of which Major J. B. Campbell, 4th Artillery, was chairman, and Lieutant (now Major General) E. M. Weaver, 2nd Artillery, was secretary. At the suggestion, it is said, of Lieut. Weaver, the idea of an artillery council was adopted and proposed to the entire artillery. By the permission of General Schofield, who obtained the sanction of the War Department to the formation of the Council, the meetings of the council were held at Governors Island, where the members assembled Oct. 3rd, 1887 and entered upon their duties. The result of these deliberations is fully set forth in the report of the council which follows:—

REPORT OF THE ARTILLERY COUNCIL CONVENED AT NEW YORK

October 3rd to 18th, 1887

HEADQUARTERS DIVISION OF THE ATLANTIC,
Governor's Island, N. Y. H., November 23, 1887.

To the Adjutant General, U. S. Army,
Washington, D. C.

SIR:

I have the honor to transmit herewith the report of an "Artillery Council" which met in New York from the 3rd to the 18th of October.

This Council was composed of representative officers from the five regiments of artillery chosen by the officers of those regiments, for the purpose of full and free consideration and discussion of the needs of the Artillery Arm of the service, and of the measures which, in the general opinion of artillery officers, would best promote the efficiency of that Arm.

This movement originated with the officers of artillery themselves, and received my official sanction, so far as was necessary, to enable the representative officers to meet for the purpose had in view. Their deliberations appear to have resulted in a concurrence of views upon many important subjects which have long been discussed, and in respect to which widely divergent opinions have prevailed. The report may, as I understand, be accepted as a fair expression of the general opinion of artillery officers respecting the measures believed to be necessary to place the artillery service upon the highest plane of efficiency. Hence, this concurrent opinion is worthy of candid and careful consideration, coming as it does from men whose lives have been devoted to this branch of the public service, and whose whole personal interests are involved in its efficiency.

While some of the measures proposed may not appear practicable, as seen from a different standpoint, or may require modification, the project as a whole seems to me to be excellent, and I trust it will be favorably considered both by the Executive and by Congress.

Very respectfully, your obedient servant,
J. M. SCHOFIELD, *Major General, U. S. A.,*
Commanding.

OFFICIAL:
Aide-de-Camp.

FORT MONROE, VIRGINIA, November 22, 1887.

To the Assistant Adjutant General,
Headquarters Division of the Atlantic,
Governor's Island, N. Y.

SIR:

Prompted by a conviction generally entertained by artillery officers that the present condition of the artillery arm of the service is most unsatisfactory, and that modern requirements imperatively demand important changes in its organization, methods of administration and system of instruction, a movement was initiated some months since by the different regiments of artillery to secure a careful consideration of these questions. This movement resulted in the selection of two officers by each regiment who were to meet for that purpose in what has been called an Artillery Council. The officers thus chosen are: 1st Artillery—Major Royal T. Frank, Captain Joseph P. Sanger; 2d Artillery—1st Lieutenant Alexander D. Schenck, 1st Lieutenant Erasmus M. Weaver; 3d Artillery—Captain James Chester, 1st Lieutenant Henry B. Osgood; 4th Artillery—Major Alexander C. M. Pennington, 1st Lieutenant Alexander B. Dyer; 5th Artillery—Major Marcus P. Miller, 1st Lieutenant John McClellan.

With the sanction of the Major General Commanding the Division, these officers met in New York, October 3d, and continued their deliberations until October 18th, when they adjourned. The result of their work is embodied in a proposed bill to increase the efficiency of the artillery, together with a statement of the reasons upon which it is based, and recommendations relating to administration and instruction. In accordance with the wishes of the Council, I have the honor to enclose these, with the request that the Major General Commanding will make such disposition of them as in his judgment will best attain their purpose.

I will add that the Council endeavored to give the fullest consideration to the important questions before it, and while its members were not in entire accord upon some features of the proposed bill, the measure, as a whole, received unanimous approval. This spirit we sincerely hope will pervade the entire body of artillery officers as well as all those who desire to promote the efficiency of our Arm.

Very respectfully,
Your obedient servant,
Royal T. Frank, *Major, 1st Artillery.*

AN ACT TO INCREASE THE EFFICIENCY OF THE ARTILLERY OF THE UNITED STATES

Section 1. The artillery troops shall consist of one brigadier general, who shall be Inspector General of Artillery, and seven (7) regiments of artillery, as many mechanical engineers (with the rank of ordnance sergeant), not to exceed two to each artillery post, as the President may direct, and one veterinary surgeon for every four batteries mounted as field artillery. The said seven regiments of artillery shall be organized as hereinafter provided, and shall consist of the five regiments now in service, and two new regiments to be known respectively as the 6th and 7th regiments of artillery.

Sec. 2. It shall be the duty of the Inspector General of Artillery to prescribe and supervise the technical instruction of the artillery, and to be at all times familiar with the condition of the arm for service. To this end he shall recommend such periodical inspections of all artillery troops and stations as may be necessary for the public service, and shall submit to the General Commanding the Army such reports and recommendations as may be required. In the performance of his duties as Inspector General of Artillery at the headquarters of the army, he may have such assistants from the personnel of the artillery as the President may authorize.

Sec. 3. Each regiment of artillery shall consist of twelve batteries, one colonel, one lieutenant colonel, three majors, one adjutant, one quartermaster and commissary, one sergeant major, one quartermaster sergeant, one chief musician—who shall be instructor of music—and two principal musicians. The adjutant and the quartermaster and commissary shall be extra lieutenants selected from the first lieutenants of the regiment; *Provided*, that the President shall apportion the officers and enlisted men of any regiment of artillery in that regiment as the good of the service may require, and may designate as skeleton batteries such number of batteries, not to exceed two per regiment, as would be officered by the number of officers absent on detached service.

SEC. 4. Twelve batteries of artillery, to be designated by the President, shall be equipped as field artillery, and two batteries as mountain artillery; two other batteries may be designated and equipped as mountain artillery when the President may deem it necessary, and to each battery mounted under the provisions of this section the President may, at his discretion, add one second lieutenant.

SEC. 5. Each battery of artillery shall consist of one captain, one first lieutenant, and one second lieutenant, one first sergeant, four sergeants, four corporals, two trumpeters, two artificers who shall be mechanics, one wagoner, and as many privates, not less than forty nor more than one hundred and twenty-eight, as the President may direct; *Provided*, that the President, at his discretion, may add thereto four sergeants, four corporals, four artificers who shall be mechanics, and one hundred and twenty-eight privates.

SEC. 6. The privates of artillery shall be divided into three classes, under such regulations as the President may prescribe, viz., recruits, privates of the second class, and privates of the first class.

SEC. 7. In time of peace there shall be two artillery schools of instruction, as follows: A school of foot artillery and torpedoes, and a school of field artillery—these schools to be located at such points as the President may designate.

SEC. 8. The Inspector General of Artillery shall receive the pay and emoluments of a brigadier general in the army. The veterinary surgeons shall have the rank, pay and allowances of a regimental sergeant major; sergeants-major, quartermaster sergeants, and first sergeants of artillery shall receive the pay and allowances of a sergeant-major of engineers; chief musicians, principal musicians, and trumpeters the pay and allowances now authorized by law for their particular grades; sergeants and corporals of artillery the pay and allowances now allowed by law to the corresponding grades in the engineer corps and ordnance department; artificers of artillery and wagoners the pay and allowances now authorized by law; mechanical engineers of artillery fifty dollars per month, and the allowances of an ordnance sergeant. The pay of privates of the first class shall be the same as now established by law for a private in the fifth year of his enlistment, the pay of a second class private shall be that now established by law for a private in the third year of his enlistment, and the pay of a recruit shall be the sum of thirteen dollars per month; and allowances for privates of the first class, privates of the second class, and recruits shall be the same as now established for privates of artillery.

SEC. 9. The original and other vacancies created by this act in the grade of brigadier general, and in the several grades of field officer and captain, shall be filled by appointment from the next lower grade in the artillery, such appointments to be made either according to length of service as a commissioned officer or by seniority as the President may deem most just; *Provided*, that after the original and other vacancies created by this act shall have been filled, all the field officers, captains, and lieutenants shall be assigned to regiments according to seniority.

SEC. 10. After the original and other vacancies created by this act shall have been filled, no officer below the rank of colonel shall be promoted until he shall have passed a satisfactory examination as to his professional ability and fitness for artillery command; *Provided*, that from and after the passage of this act all officers who enter the artillery as second lieutenants shall be promoted lineally through all grades without respect to regiments.

SEC. 11. Boards for the examination of officers as prescribed in the foreging section shall consist of three artillery officers senior in rank to the officer to be examined, and two medical officers; *Provided*, that the medical officers shall pass upon the physical condition only of the officer examined.

SEC. 12. Should an officer fail in his physical examination, his case shall be disposed of as now prescribed by law; *Provided*, that should he be recommended for retirement for disability contracted in the line of duty he shall be retired with the rank to which his seniority entitled him to be promoted, and should he fail in his professional examination he shall be suspended from promotion for one year when he shall be re-examined by a like board. In case of failure on such re-examination he shall be dropped from the rolls of the army, *Provided*, that all officers who have served as officers or enlisted men in the armies of the United States, regular or volunteer, during the war of the rebellion, shall, in case of failure on such re-examination be placed upon the retired list, and no act now in force shall be construed as to limit or restrict the retirement of officers as herein provided for.

SEC. 13. No officer shall be appointed to the artillery from the ranks or from civil life, or be transferred to the artillery from any other arm, corps, or department of the army, until he shall have passed a satisfactory professional and physical examination before a board such as is prescribed in Section 11 of this Act.

SEC. 14. All boards for the trial and testing of cannon, artillery carriages and machines, as well as all experimental boards for deciding questions of attack and defense, shall be composed in part of artillery officers, as the President may direct.

SEC. 15. When any militia artillery battery organization mustering not less than sixty (60) active uniformed members shall, through and with due approval of the regularly constituted State authorities, have signified to the President its desire to take part in the regular system of artillery drill and target practice for the army, under such regulations as the President shall from time to time prescribe, he may assign such batteries for said duty at the fort or artillery station most convenient to its rendezvous; *Provided*, that as often as any such battery of artillery shall repair to its appointed station and there duly take part in the prescribed exercises for a period of not less than six (6) nor more than sixteen (16) consecutive days in any one year, under the command and instruction of the regular artillery officers there on duty, the battery having maintained a daily presence of not less than forty (40) active, uniformed members, the members of said battery, shall, upon the muster and certificate of the commander of said post or station, be entitled to and receive the following allowances and pay, to be rovided under such regulations as the President may prescribe, viz., transortation from their regular rendezvous to station and return, such allownces of ammunition for drill and target practice as the President may deem necessary, one ration for each man per day for each day present, one undress uniform per man duly present each three annual tours of said duty, and to each officer and enlisted man actually present for duty not less than six and not more than sixteen consecutive days, as mustered and certified by the commander of the post or station, a per diem pay equal to that paid to officers and enlisted men respectively of like rank in the regular army for the same period.

In explanation of the measures embodied in the preceding act, the Council remarks:

SECTION 1. The principal features of this section are the creation of the office of Inspector General of Artillery, and the addition of two regiments to the present force. These modifications are deemed by the Council of great importance, not only to the efficiency of the artillery, but to any system of sea-coast defense which may be adopted.

The necessity for having at the headquarters of every army an artillery officer of rank who shall supervise the artillery service, and act as adviser to the Commander of the Army on all artillery matters, has been so often proven and is so universally recognized as indispensable to the efficiency of the Arm, that the Council cannot hesitate to recognize the principle, and embody it in this bill. It is recommended that the Inspector General of Artillery be attached to the Headquarters of the Army, and perform his duties under the orders of the General Commanding the Army.

These duties, which are of great consequence to an army in time of peace, are of vital importance in time of war, and cannot be assumed without great danger to the success of military operations by any officer, no matter what his capacity, who, while actively preparing for the enemy, is distracted by the necessary cares of a newly created office, but partly organized, and without intelligent and systematic rules for its operation. Upon no other question respecting organization is the artillery of all countries, including our own, so wholly united; it is the key-stone of the structure, and an indispensable condition of efficiency. It may be said, in further support of this provision, but without going too much into detail, that the manifold duties which devolve on the artillery, and the great and increasing variety of guns, complex carriages and machines, arms and munitions, the service of torpedoes, sea-coast, siege, mountain and field artillery, render it imperative that the instruction and administration of the artillery be uniform and thorough; that the armament of the forts, together with all the equipments used in handling the guns, be provided and kept in repair; and that a system of artillery defense, suited to the character and location of our forts, be devised and maintained in constant operation.

In view of the great extent of our sea-coast, and the scattered condition and varied service of the batteries, these objects cannot be achieved save through the instrumentality of a single head, with full knowledge of all the needs of the different branches of the artillery service and the proper object to be attained by each. For these reasons, and many others which might be presented, the Council urges most earnestly the favorable consideration of this measure, being assured that without a head to supervise and report upon the various branches of the artillery service, their harmonious operation and efficient condition can never be fully realized.

THE ADDITION OF TWO REGIMENTS

The ideas engendered by the late civil war, that the nation has unbounded military strength, that a foreign invasion is impossible, and that an efficient body of infantry and cavalry is all that the country requires to terminate Indian hostilities, have served to divert public attention from the actual condition and needs of the artillery during the past twenty years.

The war left us five regiments of artillery which compared favorably with the artillery of any army in the world. The government and the nation were satisfied with it, and in the various re-organizations which followed, and by which an army of 50,000 men was reduced to one of 25,000, not a word was ever heard about the artillery. The number of regiments and the number of batteries are to-day exactly as they were at the close of the civil war, but their efficiency has been sadly impaired. The number of enlisted men apportioned to the artillery has been for several years so small that batteries have been reduced below the minimum of effective strength; captains cannot find men enough to train at the more difficult duties of their profession, and rarely enough to man the heavier guns now in service.

But the position of the artillery to-day is very different from what it was during the civil war. Then the bulk of it was mounted and attached to armies in the field. Our sea-coast forts and harbor defenses were vacant or occupied by volunteer troops. We were at peace with foreign countries and our navy had been so expanded as to be able to look after the enemy's cruisers and maintain an effective blockade. The forts of New York Harbor were fully garrisoned at that time; or at least better garrisoned, so far as numbers are concerned, than they have ever been since. Yet many will remember the consternation which the bare possibility of a visit from the "Merrimac" created.

The consternation which then prevailed may be taken as a faint illustration of what would happen in case of a foreign war. Then, not one ironclad, but dozens of them might be expected any day at any of our seaports on the Atlantic or the Pacific. Now, unless such a condition of affairs be impossible, the nation should be prepared to meet it. The question of possibility may be dismissed. The duty of preparation must be assumed. The nation must look to its defenses. It is economy to do so.

The nation has been looking, but in a preparatory way, towards its seacoast defenses. Under the act of Congress, approved March 3d, 1885, the President assembled a Board, known as the "Fortifications Board," and which contained among its members not one representative of the artillery. This Board of able and distinguished officers maturely considered the question submitted to it, and from their report (pages 13 to 20) we find a statement of the defenses necessary for the protection of 27 of our most important sea-ports. New York alone calls for an armament of 239 rifled guns and mortars in addition to the guns which now garnish its defenses. San Francisco calls for 238; Boston for 175; the Lake Ports, 46; Hampton Roads, 50; New Orleans, 30; Philadelphia, 36; Washington, 13; Baltimore, 25; Portland, Me., 88; Rhode Island Ports, 70; Key West, 44; Charleston, S. C., 28; Mobile, 38; New London, 8; Savannah, Ga., 29; Galveston, 24; Portland, Ore., 51;Pensacola, 6; Wilmington, N. C., 9; San Diego, Cal., 4; Portsmouth, N. H., 8; Fort Clinch, 4; Fort Popham, 3; Defenses of New Bedford, Mass., 19; Fort Knox, 3; and Defenses of New Haven, Conn., 11—making in all 1,299 new rifled guns and mortars which the Fortifications

Board declare in their report should be added to our armament, in order that we may be reasonably secure from foreign attack.

In addition to the new armament thus recommended, the Board determined and gave due consideration to the 2,020 guns, smooth bored and rifled, now on hand and available for use.

We have then an armament on hand and available	2,020 guns.
New armament recommended	1,299 "
Total	3,319 guns.

and mortars of large caliber declared by competent authority to be necessary for the defense of only 27 of our more important sea-ports.

It is unnecessary to say that all these guns, numerous as they are and formidable as they ought to be, are only buried capital unless they be properly manned—not merely *manned*, but *properly* manned. To take a man from the plow and set him to run a locomotive would be deemed criminal by any intelligent man, but the criminality is trivial compared with setting him to operate any of the great engines of war now included in the term cannon. The nation, rich as it is, cannot afford to have untrained artillerymen. It costs on an average over a hundred dollars a shot to fire any of the higher grade of guns, and throwing such shot away, as unskilled gunners necessarily must, would be folly.

It is necessary therefore that our guns should be manned, and that our artillerymen should be trained, before either can be worth anything. The guns are useless without the men. The men are useless without the training. The question of armament having been decided by competent authority, the question arises, how many trained artillerists are necessary?

In deducing an answer to this question, which is a simple enough matter when the number of guns and their calibers are known, we run into figures so stupendous as to make us hestiate to present them. Thus to man the 239 rifled guns and mortars which, according to the Fortifications Board, are necessary for the defense of New York Harbor, we find:

18 B. L. R.,	110 ton guns,	16	artillerymen	each,	288	men.
2 "	80 "	16	"	"	32	"
40 "	50 "	12	"	"	480	"
20 "	27 "	8	"	"	160	"
15 "	13 "	8	"	"	120	"
144 mortars,	12″ caliber,	8	"	"	1152	"
Total					2232	"

And as three reliefs are required to maintain an action even for one day, we have 3 x 2,232 = 6,696 artillerymen which would be absolutely necessary to make the proposed armament for the defenses of New York effective.

Moreover, the number of serviceable smooth bore guns and converted and other rifles which now arm the defenses of New York, or are in position to be mounted, and which will by no means be entirely superseded by the more powerful guns to be provided, are more numerous than the new armament will be, and require for their efficient service quite as many artillerymen. It would, therefore, take to fully man the guns in New York Harbor alone, if that harbor had to be defended against an iron-clad enemy, fully

13,392 artillerymen; and it has been calculated that for the defense of all our sea-coast forts against a foreign enemy at least 85,000 artillery troops would be necessary.

But it is unnecessary to maintain a status of war in time of peace. While 85,000 artillery troops would be necessary should the nation be called upon to fight for its life against a foreign enemy, a much smaller number will suffice to keep alive the art of the artillerist, and to constitute the leaven which will leaven the larger lump in a reasonable time. As a rule, one-fifth the war strength is taken as the peace footing of artillery troops, but this would call for such a large increase of our present handful of men, that the Council hesitates to ask for it. But one-tenth is not an unreasonable demand. That there should be one instructed and trained artilleryman in every ten needed at the outbreak of hostilities cannot be called an extravagant demand. If we desire the mass to rise to the level of efficiency, we must give it that amount of leaven. Besides, that number of men will be necessary to care for the armament and artillery machines when they are provided, as recommended by the Fortifications Board, and half that number to properly care for the armament already on hand.

As, therefore, the number of artillery troops which should be maintained when the new armament is in position is 8,500, or one-tenth of the war strength, so the number which should now be maintained is 4,250, or one-twentieth of that strength. It is unnecessary to add one word of argument in support of this calculation. It is absolutely the minimum required.

At this point, the question of an equitable apportionment of the enlisted men of the army to the artillery, cavalry and infantry presents itself. Remembering that the proper instruction and training of an artillery soldier is a task which takes years to accomplish, and that the number of 4,250 is the minimum artillery strength, we have, under the present limit fixed by law—

7 regiments of artillery of 600 men each, plus 50 mechanical engineers	4,250
10 regiments of cavalry of 600 men each	6,000
25 regiments of infantry of 500 men each	12,500
	22,750
Engineer and ordnance troops, recruits, etc.	2,250
Making in all	25,000

Section 1 also provides for mechanical engineers, the necessity for which can be no longer overlooked. The machines used in the manipulation of the guns now on hand are of a nature demanding the attention of expert mechanics, and as the new armament comes in, and is put in position, steam and electricity will become essential adjuncts to the service of the guns. Besides, the presence of such men at artillery stations even now would be an economy, for many an expensive machine has been rendered useless for want of the timely attention of a skilled mechanic. It is impossible to procure skilled machinists—men who are able to make or mend the most
plicated machines, run steam engines, or attend to the electrical outfit
modern fort—for the pay and allowances of artificers, who are merely
smiths, wheelwrights, or saddlers. Hence the necessity for the new
It is important that the mechanical engineer of artillery should

be an enlisted man, otherwise he might terminate his contract with the Government at the very moment when his services were indispensable.

THE ORGANIZATION OF THE REGIMENT

SEC. 3. That the seven proposed regiments should consist of the five regiments now established by law, and two new regiments to be known as the 6th and 7th regiments of artillery, needs no remark; but the proposed *organization of* an artillery regiment introduces some new features which call for explanation. These new features are contained in the proviso added to Section 3 of the proposed bill. They authorize the President to apportion officers and enlisted men of each regiment as the good of the service may require, designating the batteries thus deprived of their enlisted men as skeleton batteries.

The necessity for this proviso arises out of the fact that there are certain detached duties to which officers of artillery may be legally, and are actually, detailed and separated from their batteries. The efficiency of batteries is always impaired by such legal and necessary details, and it is thought that the good of the service, the efficiency of the batteries, and the instruction of the soldiers themselves would all be enhanced by maintaining not to exceed two skeleton batteries per regiment, to which the officers absent on such details should be transferred; their quota of enlisted men to be distributed to the other batteries of the regiment as the good of the service may require. The number of officers available for detail in any one regiment would be 6, and for the seven regiments 42, which is 6 below the number actually absent on detached service at this date.

SEC. 4. This section provides for two additional field batteries, which, the Council recommends, should be equipped as horse artillery, and two mountain batteries, making a total of fourteen batteries for service in the field, or two per regiment as at present authorized. Mountain artillery has received but little recognition in our army, and as it is a most valuable auxiliary in all mountain warfare, the Council has deemed it advisable to incorporate in this bill a provision conferring upon the President the same powers in regard to it which he has heretofore exercised in regard to field batteries. The absence of trained mountain batteries from our army during the past twenty-five years has, it is believed, jeopardized and prolonged many expeditions against our hostile Indians.

In most of these operations the artillery has taken no part, except as infantry, the artillery service proper having devolved on the infantry or cavalry, with improvised batteries, unsuited in most respects for such service. The artillery should provide all such details and should have its share of frontier service, but in its legitimate and appropriate character. All nations which have conducted military operations in mountainous regions have fully appreciated the value of mountain batteries and have sought to perfect them. There are many foreign models worthy of imitation, but the Council refrains from making any recommendations on this point, feeling satisfied that, so soon as the service of mountain batteries becomes an established duty of our artillery, the proper organization and material will be readily suggested. It is recommended that the mountain batteries provided for in the bill be located at such points as will secure their participation in any expeditions which may be conducted in mountainous regions.

THE ORGANIZATION OF THE BATTERY

Sec. 5. The provisions of this section differ from the present statute in reducing the number of lieutenants, fixing the minimum number of privates at forty, and the maximum at two hundred and fifty-six, which is not more than would be required as the war strength of a foot battery. In reducing the number of lieutenants the Council has sought to remedy an evil which for many years has injuriously affected the efficiency of the artillery by its effect on promotion, especially in the lower grades.

When we see gray haired lieutenants of over twenty years' service—and there are many such in the artillery to-day—we naturally think that we see one of the fundamental causes of the existing apathy. Such men must become disheartened, and lose the zeal which should animate all officers in the lower grades of their profession. If an officer fails to reach the rank of captain until he is past the age of maximum activity, he enters upon the important duties of that grade handicapped with years, and destitute of sufficient ambition. An officer should reach the grade of captain in less than 15 years' service.

The slowness of promotion in the artillery arm has resulted from a multiplicity of causes, but the chief and glaring cause is the double line of first lieutenants. A young man entering an infantry regiment has twenty-two rounds to climb in the ladder of promotion to reach the grade of captain, while in the artillery arm he has thirty-eight rounds to climb. To remove this disadvantage the double line of first lieutenants in the artillery should be abolished. A foot battery requires but two lieutenants, a mounted battery but three, for which provision has been made in Section 4. The addition of two new regiments will, it is hoped, revive and equalize the flow of promotion, and at the same time provide for all the first lieutenants of the old regiments rendered supernumerary by this section. Thus:

The number of first lieutenants rendered supernumerary	60
The number of first lieutenants promoted to captaincies in new regiments	24
The number promoted to fill vacancies created by promotion of captains to majors in the new regiments	6
The number promoted to fill the vacancies arising out of the appointment of colonels and lieutenant colonels of new regiments	4
The number promoted to fill vacancy arising out of the appointment of Inspector General of Artillery	1
	35
Number transferred to new regiments	26
Total provided for	61

which would cause the promotion of one second lieutenant.

The only officers actually added to the whole number now in the artillery would be one Inspector General and nineteen second lieutenants of the new regiments.

It is not deemed necessary to enter into the distribution of enlisted men to batteries. The two skeleton batteries authorized in each regiment afford a ready means of strengthening batteries above their normal organization. Still, if all were completely organized, they would each have 48 enlisted men, after deducting 2 men for the non-commissioned staff and 22 for the regimental band. Then if the 96 men of the skeleton batteries were assigned, 32 to each of the mounted batteries, giving them an enlisted strength of 80 men each, and 5 men to every foot battery, giving them an enlisted strength of 53 each, it would give every battery an effective peace strength, and leave 4 men to spare.

CLASSIFICATION OF PRIVATES

SECS. 6, 8. In these sections the Council has provided for the classification and pay of the privates, which should depend upon intelligence and good behavior, and not wholly upon length of service. Similar rules of compensation are observed in nearly all other vocations and are designed not only to stimulate but to reward faithful, meritorious and useful employees. Under the present system, the increase of pay depends almost entirely on length of service, and the ambitious, intelligent and trustworthy soldier receives no greater compensation after a service of five years than the indolent, unreliable and ignorant. By dividing them into classes and requiring certain proficiency in a recruit before advancing him to the second class, and a correspondingly greater proficiency before he enters the first class, the private soldier will soon understand that both his pecuniary interest and professional standing depend upon a zealous, intelligent and faithful performance of his duties.

In section 8 the Council has also fixed the pay of the Inspector General of Artillery, as well as that of the veterinary surgeons, sergeants-major, quartermaster sergeants, chief musicians, principal musicians, 1st sergeants, sergeants, corporals, artificers and mechanical engineers. It will be observed that sergeant majors, quartermaster sergeants and 1st sergeants have received a slight increase in their pay, which is made to correspond with the pay of a sergeant major of engineers, and that sergeants and corporals of artillery will receive the pay of the same grades in the engineers and ordnance. In view of the high order of intelligence necessary for the service of modern sea-coast artillery, which now requires a more reliable body of non-commissioned officers than that of any other branch of service, this increase of pay is not considered unreasonable by the Council. The pay of mechanical engineers is fixed at fifty dollars per month, which in view of the service to be rendered by them is the least amount which it was thought by the Council would secure reliable mechanics.

THE LEGAL ESTABLISHMENT OF THE ARTILLERY SCHOOLS

SEC. 7. The establishment of the artillery schools on a legal basis has long been considered essential to their proper administration and the full attainment of their object. A small annual appropriation is needed to carry on the instruction properly, and to meet the exigencies which arise at all institutions of learning. The importance of these schools, in continuing habits of study and investigation on the part of our officers, and in enabling them to complete, to great advantage, the education they receive at West Point and elsewhere, should be, apart from any other cause, a sufficient reason for their legal establishment and maintenance; and it is recommended that those officers who fail to pass the requisite examinations, be suspended and treated in all respects as prescribed in Section 12 of this Act.

THE VACANCIES CREATED BY THE ACT

SECS. 9, 10. Two rules of promotion are now in operation in the army, under the law as interpreted. By one rule, promotion to the grade of captain is made by regiment, by the other captains and field officers are promoted lineally, according to seniority, throughout the entire Arm. The enforcement of these rules has given rise to great inequality of promotion among officers of the same age and length of service, and been the occasion of wrongs which it is now impossible to remedy without the interposition of Congress. In this connection the Council respectfully invites attention to Section 1204 of the Revised Statutes of 1878, on which these rules are now operated, and asks as a question of great concern, not only to the artillery but to the army at large, that steps be taken to determine its meaning. Tested by the wording of the statute, one or the other of the aforesaid rules must be wrong; there is certainly no authority in the statute for both rules, and the effect of the present mixed system of regimental and lineal promotion is manifestly injurious to the discipline of the army.

The Council can find no better expression of its views on this subject than those embodied in the following statement of the question by a distinguished General Officer of the Army:

"Uniformity in promotion under like circumstances is one of the most essential conditions of the efficiency of an army. Nothing else does so much to dampen military ardor as the sense of hopeless injustice in respect to promotion. As an example of this, among the present first lieutenants of artillery the terms of service as second lieutenant varies from *nine months to eleven years.* So that, of two young officers starting under similar conditions, and rendering essentially the same service, the one outstrips the other in the first stage of their career by *ten years* in the race for promotion to the higher grades. The result of this is, under the present law of retirement, that the younger in years first reaching the highest grades, retain them until all those who are older but less fortunate have passed the age of retirement. Thus a large proportion of young officers having a few juniors in years promoted over them see at once that their cases are hopeless. They are doomed to perpetual inferiority, and must finally be set aside without any hope of the reward which every soldier covets. It will be seen from an examination of the Army Register that *eighty* of the present artillery officers have already been thus debarred from promotion to the rank of colonel, sixty-two from promotion to lieutenant colonel, and thirty from promotion to the grade of major, except by the death or disability of officers who are *younger than themselves.* A reversal of the law of nature is their only hope. Surely an evil so destructive to military ambition should be remedied without unnecessary delay."

But owing to the many personal interests involved, and the extreme and bitter differences of opinion springing therefrom, and now prevailing among artillery officers, the Council, while fully appreciating the evils resulting from the present rules of promotion, is unable to propose any method by which such differences can be *wholly* reconciled, and active and serious opposition to its recommendations prevented. *Lineal promotion throughout the arm, based on efficiency and length of service,* is, doubtless, in view of the present law of retirement, the only just rule of promotion to establish in the army, and the Council has therefore embodied this principle in its bill, but restricted the application of it to those officers who cannot be injuriously affected by its immediate application, but who, on the other hand, as they advance to the higher grades, will escape the evils of the present system.

Of all the questions debated by the Council none has been as difficult as that affecting promotion, and while the Council does not pretent to have been able to adjust the matter so as to render their action acceptable to all, it has endeavored to settle the question in accordance with established rules, and with a view to doing all that can be done to help those officers whose advancing years and inferior rank will soon render all assistance unavailable.

The Council expresses the wish that, in filling the vacancies created by this Act, the President will consider some of the glaring inequalities of promotion which have occurred under existing rules among officers of the same date, and endeavor to rectify them as far as the best interests of the service will admit.

SECS. 10, 11, 12, 13. These sections provide for examinations for promotion and transfer, and require but little explanation. No one who has watched the wonderful advance of artillery science during the last twenty-five years will deny that it is a progressive science, demanding constant practice and study. To secure such attention among artillery officers is important, and examination for promotion is considered the easiest and most effective way of doing it. The proposition is simply that before an officer is commissioned to command, he must satisfy a proper board that he has the necessary qualifications. No reasonable objection can be made to such an examination. It is not designed for the purpose of exposing ignorance on abstruse questions of science, but for the purpose of ascertaining whether an officer has improved his opportunities, and prepared himself for the *professional* responsibilities of the higher grades. With it a reasonable degree of excellence is assured in all grades; without it the ignorant, inefficient, and indifferent come to their reward by ordinary promotion as soon as the ambitious, the laborious, and the most accomplished of our officers.

SEC. 14. The provisions of section 14 have long been considered indispensable to the efficiency and experience of artillery officers, as well as to the intelligent choice of artillery material, and the proper settlement of questions of attack and defense. It is not sufficient, in the opinion of the Council, that artillery officers are occasionally, and through courtesy, assigned to the duties referred to in this section; they have for all reasons a vital interest in such subjects, not only on account of their intelligence but their practical experience, and the fact that no matter what theories may be finally adopted in reference to artillery material, and to questions of attack and defense, it is they who will be required to test them. Upon them will devolve the service of artillery in the field, along our seacoast and Northern lakes, and they have an undoubted right to take part in every discussion bearing upon their responsibilities in time of war, as well as upon the artillery and engineer structures which may be required for the national defense.

THE INSTRUCTION OF MILITIA BATTERIES

SEC. 15. No argument seems to be necessary in advocacy of this measure, which has in view the disemination of practical artillery skill among a most intelligent class of our citizens. Nevertheless, the Council would observe that while a reasonable degree of proficiency may always be expected among our hastily organized infantry and cavalry, the complex nature of modern sea-coast artillery forbids any such anticipation in regard to artillery troops. These must be carefully trained and instructed in advance of any emergency which may arise, and which they are expected to meet. That such emergency will be sudden and unexpected no one familiar with the initiation and progress of modern wars will seriously deny.

In this connection, and for the reason that the State militia is local in character and maintained chiefly for State purposes, the Council recommends that steps be taken to organize in the several States a National Volunteer Artillery Reserve, to be under the orders of the President, and to be thoroughly instructed in the various duties of sea-coast artillery. In the opinion of the Council an organization by battery is better adapted to this purpose than one by regiment, being far more flexible, more easily assigned, disciplined,, and incorporated into the various regular garrisons of our fortifications than regiments would be. With such a force in existance, regularly attached to the several forts, and designated by their names, the danger of a sudden invasion of our harbors by hostile fleets would be greatly diminished and in the event of hostilities, means would be provided for the expansion and increase of the regular regiments. The Council believes that the President should have authority in such a case to add not to exceed fourteen regiments to the number provided for in this act.

To recapitulate, the Artillery Council submits for legal enactment—

1. That an Inspector General of Artillery be appointed to act as adviser to the General Commanding the Army in regard to artillery matters, to supervise and direct the instuction of the artillery, and to look after its welfare and efficiency.

2 That there be seven regiments of artillery, with a minimum enlisted strength of not less than four thousand two hundred and fifty men (4250).

3. That two more field, and two mountain batteries be equipped for service.

4. That the second line of first lieutenants be abolished.

5. That the privates of artillery be classified according to their intelligence and professional worth.

6. That the artillery schools be established on a legal basis.

7. That the pay of non-commissioned officers of artillery be made to correspond with that of non-commissioned officers of the ordnance and engineers, and that privates be paid according to classification.

8. That in filling the vacancies created by the act, the President correct as far as practicable the inequalities resulting from the present rules of promotion, and that on and after the passage of this act, all second lieutenants entering the artillery be promoted lineally throughout the arm, without respect to regiments.

9. That officers be examined for promotion, and for appointment or transfer from other branches of service to the artillery.

10. That artillery officers be given some voice in the selection of our cannon, etc., and in questions of attack and defense.

11. That suitable provision be made for the instruction of our artillery militia.

SUGGESTIONS

In addition to the foregoing legal enactments, the Council respectfully offers the following suggestions respecting the artillery service:

1. It is proposed that Article XXXVIII. of the Army Regulations be modified so as to read as follows:

ARTILLERY ADMINISTRATION AND INSTRUCTION

PAR. 460. The command and administration of the artillery troops shall be such as to develop the greatest proficiency in the use of all cannon, machine-guns, torpedoes, arms, implements, and munitions of war, and such troops shall not be ordered on detachment not connected with the artillery service, except in cases of emergency, or when other troops are not available.

The colonels or commanding officers of artillery regiments shall, under the Department and Division Commanders, have actual command of all the posts, except artillery schools, garrisoned by batteries of their respective regiments, so that they may exercise the supervision and control necessary to the highest degree of efficiency. Such command shall be officially designated an "Artillery District."

At the headquarters of each Division in which one or more regiments of artillery may be stationed, there shall be attached to the Division Staff a field officer of artillery, who shall be known as the Inspector of Artillery, and who shall make such inspections and perform such artillery duties as the Division Commander may direct.

When an artillery officer is appointed or succeeds to the permanent command of a fortification or other important artillery post, he shall prepare a plan in detail of the artillery defense of his post, having reference to the attack by land as well as water, when the two approaches are possible. The plan will not only embrace the artillery defense proper, but the defense by torpedoes and mines, and will enumerate the required strength of the garrison, the character of the armament and its protection, the amount of ammunition, and all that may be necessary to place the post in a state of defense. Such sketches or drawings as may be required by way of explanation will accompany the general plan, which, when completed, will be forwarded to the Adjutant General's office through the usual channels. A copy of the plan will be retained at the post in the custody of the commanding officer. It will be communicated to the officers, and made the subject of instruction. This information will be regarded as confidential, and will not be communicated without proper authority.

INSTRUCTION AT POSTS

At all posts except the artillery schools, where not less than one battery of artillery is present, the course of instruction will be conducted as follows:

The senior officer of artillery on duty at any post has, under the direction of the post commander, the supervision of artillery instruction, and the general direction of the artillery service. At posts garrisoned by artillery alone, the post commander has authority to assign to the artillery officer next in rank to himself such of the duties pertaining to *instruction* as he may deem advisable.

The instruction of the officers and enlisted men shall be both practical and theoretical, and the two courses shall be apportioned to the different months and seasons according to the climate of the artillery stations.

The practical course shall continue for seven months, and the theoretical course for four months, the remaining month shall be a term of relaxation from all but necessary garrison or field duties, and shall preferably separate the two courses of instruction.

During the four months of each year set apart for the purpose, there shall be maintained at each artillery post where one or more batteries of artillery may be stationed, a day school for the instruction of the enlisted men. The sessions of the school will not exceed one hour and a half each, and will take the place of the drills and other practical instruction given during the remainder of the year.

The course of instruction will embrace reading, writing, arithmetic, elementary algebra, geometry, trigonometry, and military surveying;practical electricity, artillery material; the use of maps and globes, and so much of the Army Regulations as pertains to field and garrison duties. Only such portions of the various subjects shall be taught as will enable the enlisted man to handle the machines, and understand the practical problems connected with their artillery duties, and the text books shall be arranged accordingly. Attendance at the school shall be compulsory; the instruction shall be proportioned to the abilities and requirements of the men, and the instructors shall be commissioned officers, assisted by such non-commissioned officers as may be necessary.

The theoretical instruction of artillery officers shall be given during the season set apart for the post-schools and will be generally of such character as to prepare them for the full performance of their duties. The subjects of invesitgation, recitations, lectures, and essays shall be given out annually by the Inspector General of Artillery, who shall be governed in his selections by the immediate needs of the artillery and the character of the service performed, as field, mountain, siege, or sea-coast artillery. Historical accounts of sieges and battles should be analyzed mainly for the purpose of explaining the rôle of the artillery, and wherein it achieved or failed to accomplish its object.

The *practical course* of instruction shall include all branches of the artillery service, and shall be uniform in each branch.

The foot batteries shall be thoroughly instructed as follows:

The manual of the field piece, including all rapid firing machine guns, mechanical maneuvers, ammunition, implements and equipments—twenty days.

The manual of the siege guns and howitzers, coehorn and all other mortars, the mechanical maneuvers, the preparation of ammunition, the laying of platforms, the fabrication of trench material, and the practical demonstration of laying out parallels, zig-zags, and the tracing and defiling of seige batteries—forty days.

The manual of all sea-coast guns in service, the mechanism of the carriages, the mechanical maneuvers of mounting, moving, and dismounting the guns, the service of ammunition, electric batteries and machines—forty days.

Artillery target practice, including the tracking of vessels, the estimation of distance, and the firing—twenty days.

Infantry exercises and small arms target practice, signalling, and the use of the telephone and telegraph—forty days.

In this connection the Council respectfully invites attention to the great deficiencies in the necessary means of instruction at the several artillery posts in the army, and especially in the Division of the Atlantic. It may be stated, without fear of denial, that there is not a single artillery post in this Division, excepting, perhaps, Fort Monroe, which has even the necessary means of artillery instruction, and not one with the proper facilities for target practice. This is due in great measure, but not wholly, to the failure of the annual ordnance appropriation, from which all artillery supplies are purchased; and inasmuch as such a failure may again occur and the present deficiencies continue, the Council respectfully suggests the propriety of a special annual appropriation for artillery instruction and target practice, which shall cover present necessities, and thus provide for the efficient service of our artillery troops.

PAR. 461. The senior officer of artillery on duty at the post shall render monthly reports of the progress and kind of instruction given to the commissioned officers and to the enlisted men of the post school. At the termination of the theoretical course, the industry and proficiency of the officers and the standing of the enlisted men in the various branches taught in the school will form the subject of a special report. These reports will be made to the Adjutant General of the army, and extracts from the same, of so much as relates to their regiments, to their respective commanders.

Regimental commanders will require of battery commanders reports of—

1. Means of instruction at post.
2. Progress and kind of instruction given their batteries.
3. Number and dates of drills, exercises, and recitations apart from those of the post school.

At the termination of the course of instruction, regimental commanders will forward abstracts of all these reports through the regular channels to the Adjutant General. The commanders of artillery regiments have authority to call upon the senior artillery officer on duty at any post where batteries of his regiment may be stationed, and upon the battery commanders, for any information concerning the instruction as prescribed in this paragraph, or the non-rendition of reports, and it is made the duty of all artillery officers thus called on to render full and prompt reply.

THE ARMAMENT

PAR. 462. At all posts with fixed batteries, the position of every gun, mounted or to be mounted, will have its number, and this number will be placed on the gun when in position. The guns will be numbered in a regular series, commencing with the first gun on the left of the main enterance, looking out. Where there are platforms temporarily unoccupied by guns, they will be included in the regular series of numbering. The pieces of other batteries will be numbered from right to left, in the same manner.

TARGET PRACTICE.

PAR. 463. At all posts with fixed batteries, a book will be kept, to be known as the "Record of Artillery Firing," in which, under the direction of the commander of the post will be duly entered the number of each mounted gun, its calibre, weight, names of founder and its inspector, and other marks; the date of reception at post, and where from; the greatest field of fire of the gun in its position, the kind of carriage on which mounted, and all the data indicated by the headings. In the column of remarks will be noted any other information useful in explaining the history of the gun and its fire.

There shall be established at every garrisoned artillery post having a battery of sea-coast or siege guns, or the necessary emplacements for such guns, one or more carefully measured base-lines, of suitable length, the extremities of which shall be permanently marked, placed under cover, and otherwise made suitable for the use of angle-measuring instruments. The azimuth of these base-lines shall be determined as accurately as possible, either by direct observation or by connection with points already well determined by reliable surveys. Adjacent forts will be connected by a base-line in addition to their local bases, so that each garrison may have the benefit of the firing executed by the other, and to effect a concentration of fire in case of necessity.

The direction of the base-line shall be such as to make them available for tracking and locating vessels which may enter the waters commanded by the guns, and in locating the shots which may be fired in the annual artillery target practice. If there be not suitable instruments at hand for the determination of the base-lines, a request will be made by the post commander on the nearest engineer station for the loan of the necessary instruments, when, if they cannot be had, application will be made to department headquarters.

As soon as established the base-lines will be plotted on the required chart of the harbor, a tracing of which will then be forwarded to the Adjutant General. The commanding officer of each post where there are fixed batteries bearing upon a channel, will call upon the Engineer Corps for accurate charts showing the soundings to the extent of the range of the guns. From these charts the post commander will cause to be prepared a similar chart or map, on the scale of 100 yards to the inch, of the harbor or water channels within range. This will be divided into one hundred yard squares, which will be numbered along the upper margin from left to right, and along the side from the top down. Tables will then be prepared showing the direction and distance to the center of each square, so that a gun can be pointed in the direction of any square with the elevation corresponding to the distance. The chart will also show the position of the batteries, the outline of the shore for a distance of at least three miles, the shoals, reefs, islands, light-houses, buoys, beacons, fog-bells, spindles, etc., which may be useful in determining the range. As occasion may require, buoys or other marks will be placed in the channels at the extreme and intermediate ranges, and where so placed they will be numerically noted on the charts. The charts and book of artillery record shall be in the care of the post commander.

In conducting target practice with heavy guns, the following will be observed:

1. Each battery commander will superintend the firing of his battery, and will be held responsible for the execution of all the details connected therewith, and for the prompt rendition of all required reports.

2. The preliminary arragements, except stationing the officers and

men and placing floating targets, should always be completed the day preceding that on which the firing is to take place.

3. On the day of practice the officers, men and targets should be stationed so that if the range be clear of obstacles the firing may begin at the earliest practicable hour in the morning. Three floating targets will be kept in readiness at each post, so that no delay on that score need occur. At posts provided with steam launch service the target in use will be brought in and placed under proper guard at night, if necessary.

4. Before the firing begins, and after its termination, the battery commander will inspect the guns, the carriages, the platforms, implements and equipments, and will make a written report on their condition to the commanding officer. This report will be forwarded to the Adjutant General, and will state damages, accidents, etc., together with any suggestions for the improvement of the ammunition, the material, or the drill, to which the practice may give rise.

5. During the practice no projectile will be fired directly over a vessel, or when there are vessels or boats near the line of fire; nor will case-shot or loaded shell be fired when vessels or boats are near enough to be in the least danger of injury.

6. All charges and projectiles will be *weighed*, and the weights compared with those given in the books and derived from calculation.

7. In the practice with guns the firing will take place at such distances as may be ordered by competent authority, and no battery will be permitted to fire at the longer distances until the firing at the next shorter distance has been satisfactory. With this exception the shots will be proportionately divided between the distances.

8. At the time of practice a careful record will be made of every shot fired, according to the prescribed form, an extract of which will be made in the book of artillery record. It is of the greatest importance that the whole number and character of rounds to which a gun has been subjected in practice be at all times known.

9. The figure of merit will be by battery, and will be based on the mean deviation as indicated by the plotting and record of firing.

10. At posts provided with electric batteries and a sufficient amount of wire, the season of practice will conclude with one or more volleys. Blank cartridges alone will be used in volley firing, unless projectiles are specially authorized, but all the guns will be directed at the same object or square, and their position will be verified after the volley is fired.

PAR. 464. To each battery of foot artillery there will be allowed for drill as many blank cartridges and friction primers as may be necessary for instruction, and for target practice fifty rounds of ammunition, twenty rounds of which may be of calibre above 8″. At posts garrisoned by infantry or cavalry, where there are one or more pieces of artillery, a reasonable allowance of ammunition per gun for target practice and instruction may be allowed. For target practice with rapid firing machine-guns using bullets, one thousand rounds will be allowed for each gun above fifty-one-hundredths of an inch caliber, and two thousand for all calibres below, to be expended and accounted for in the same manner as small arm ammunition. For practice with revolving cannon, one hundred rounds per gun for calibres above 1½ inches and two hundred rounds for all calibres below 1½ inches. Blank cartridges will not be fired from machine guns. Artillery target practice will take place during such months as the Division Commander may direct.

The ammunition used for drill and target practice in all cases will be selected from the serviceable ammunition which has been longest on hand at the post. The practice will be conducted with great care and at suitable targets and whenever practicable shall include all the different kinds of fire, such as direct, vertical and curved fire. The targets will be such as may be prescribed from time to time and will be furnished by the Quartermaster's Department.

After the completion of artillery firing, whether for practice or in battle, a report will be rendered according to such form as may be prescribed, and forwarded through the regular channels to the Adjutant General of the Army for the information of the Inspector General of Artillery; a copy will be sent to the Chief of Ordnance. Practice reports will be accompanied by a plotting of the shots.

FIELD ARTILLERY

PAR. 465. The administration of field batteries at posts garrisoned by mixed commands will approach as closely as possible to the customs and observances of field service. Therefore, except in regard to courts-martial, councils of administration, and boards, the routine of the battery and the duties of its personnel will be regulated by the battery commander in conformity with the tactics and regulations subject to the approval of the post commmander.

The field and mountain batteries shall be commanded by such captains as the President may designate on the recommendation of the regimental commanders, who will name the captains in the order of seniority best qualified for the service. Such details shall continue for four years only, unless the President should otherwise direct.

Lieutenants of artillery will be attached for instruction to the field and mountain batteries, but no tour of such service shall continue in time of peace for more than two years.

The course of practical instruction for field artillery will embrace the necessary drills, instruction in equitation and in the use of the pistol and sword, a thorough knowledge of harness, vehicles, and the subject of draught as applied to wheeled carriages; the anatomy, physiology and pathology of the horse; horse shoeing, stable management, practice marches, target practice, and, when practicable, the embarkation of batteries in boats and by rail, and the construction of earthworks suited to hasty artillery cover.

Every battery of artillery actually armed and equipped as either a field or mountain battery will be allowed for annual practice as many blank cartridges and friction primers for instruction and drill as may be deemed necessary by the battery commander, and approved by the post commander.

Such batteries will also be permitted to expend in target practice annually fifty projectiles for each gun; a record of the firing will be kept and a report rendered as prescribed for foot batteries.

THE STATIONS OF FOOT ARTILLERY

II. The Council most respectfully suggests the location of the foot batteries at harbor posts where instruction in all branches of the artillery service may be thoroughly imparted, and the officers and enlisted men rendered familiar with the measures suited to the defense of the sea-coast. At such stations as Washington Barracks, Newport Barracks, Little Rock Barracks, St. Francis Barracks, Mount Vernon Barracks, and Jackson Barracks, it is understood that proper artillery instruction is not and cannot be given, and that the garrisons are occupied with duties which might be performed to greater advantage by the infantry or cavalry. It is vitally important that the field batteries be assembled in commands of not less than three or four batteries. In their present isolated state and reduced strength they fulfil quite imperfectly their rôle as batteries of instruction, and render futile all attempts to diffuse correct knowledge of their object on the battlefield. It may be said, that except for the service of guards, the use of field artillery in detachments of less than two or more batteries is not sanctioned by the experience of recent wars, and it is therefore highly important that the administration of our field artillery be such as to bring this principle forcibly to the attention of all artillery officers, and to prepare them for the proper management of this branch of the artillery service.

In this connection the Council recommends a slight increase of the pay and clothing allowance of the enlisted men of the field artillery as a compensation for the additional duty incident to their calling, and the wear and tear of their uniforms.

During the past nine years 27 per cent of all the artillery desertions have been from the mounted batteries, although from 1877 to 1881 there were but five mounted batteries out of sixty, and from that date but ten. This fact points to the dissatisfaction of the enlisted men of the mounted batteries, who while performing double, and in some cases three times as much routine service as is done in the foot batteries, receive the same pay and but 15 dollars more clothing money during a term of five years. This equality in the pay of all artillery soldiers no doubt resulted in some measure from the idea of assimilation which prevailed shortly after the war, and which, beginning with the tactics, finally extended to military administration. It is unquestionably a source of discontent and in many cases of desertion.

The Council respectfully recommends, that at least two of the field batteries be equipped as horse artillery, a branch of the artillery service not represented in our army, and concerning which no practical instruction is given.

ARTILLERY SCHOOLS

III. As it is the policy of the Government to maintain schools for the higher education of its officers the Council respectfully offers the following suggestions, based upon experience, in respect to the management of the artillery schools:

1. The command should be entrusted only to officers of *well known* fitness for the duty, and too much care cannot be taken in ascertaining this fact.

2. The commanding officer of a school and the superintendents of instruction thereat, should constitute a Board of Administration (for the

school) which should meet each week to act on matters of school administration.

3. The same officers with all the instructors added, should constitute a Board of Instruction to meet at least monthly to act on all questions of instruction, and to determine finally the proficiency of the officers.

4. The officers under instruction should form two classes, and should not include, without his consent, any officer who has already passed through the school successfully, or one who is beyond the appropriate age for such instruction, say fourteen years' service.

5. The course of instruction should be largely post graduate of West Point, and should conform closely to the special objects of the school.

The instruction should continue two years, as follows:

1st year. Practical course and the usual post duties.
2d year. Theoretical course, solely.

Nothing can be more prejudicial to good work in the theoretical course of instruction than the constant interruptions of study and investigation occasioned by the daily demands of guard-duty, drills, boards, courts, signalling, target-practice, roll-calls, parades, issues, etc., etc., routine duties which prevail at all posts, which are important and serve a necessary purpose, but which should not impair the full value of the theoretical instruction. The Council is of opinion, that owing to the limited time of the schools, the theoretical course should embrace only those subjects requiring the assistance of an instructor, and the special appliances not to be found at ordinary artillery posts. Subjects upon which officers have already been examined and pronounced proficient, either at West Point or elsewhere, or which pertain to the profession at large, and which can be pursued by an officer in the ordinary course of his service without an instructor, should form no part of the curriculum or infringe upon the time necessary for the special instruction for which the schools are established.

With this principle in view the Council recommends that the course at the Foot Artillery School, Fort Monroe, be as follows:

Department of Artillery.—Ballistics, interior, exterior and penetration, designing and construction of guns, carriages, machines, artillery implements and equipments, ammunition, explosives, torpedoes, electrics; the organization, administration, and tactical employeymnt of sea-coast, siege and garrison artillery.

Department of Engineering.—Fortifications as far as connected with the artillery arm, mechanical engineering as far as it applies to the service of artillery.

Practical instruction in the above subjects would, with the usual post duties, comprise the practical course.

The theoretical course of instruction at the Field Artillery School should supplement in a measure that followed at the Foot Artillery School, and should embrace strategy and grand tactics; the organization, administration and the special employment of artillery in campaigns, combats and battle; anatomy, physiology and pathology of the horse, and so much of engineering as pertains to hasty surveys, and cover for troops and guns; ary bridges and roads.

e practical course should be as prescribed in Article XXXVIII. of egulations, as proposed by the Council. Assistant instructors are ary at both schools.

The Council further suggests that an Artillery Board of not less than three members be convened for the purpose of preparing a set of suitable text books for the artillery post schools recommended to be established, and that an Artillery Board of five members be convened to propose a system of target practice suited to our field batteries and sea-coast defenses, and that the post book of Artillery Record be changed so as to conform to the accompanying blank form.

Finally, the Council expresses the hope that the subjects of this communication may receive the consideration to which they are fairly entitled. Whatever interest they may have for others, they are deemed of great importance to the artillery, and it is confidently believed by the Council that if approved by the military authorities, they will command the favorable action of Congress.

R. T. Frank, *Major, 1st Artillery.*
J. P. Sanger, *Captain, 1st Artillery,*
A. D. Schenck, *1st Lieutenant, 2d Artillery.*
E. M. Weaver, *1st Lieutenant, 2d Artillery.*
J. Chester, *Captain, 3d Artillery.*
H. B. Osgood, *1st Lieutenant, 3d Artillery.*
A. C. M. Pennington, *Major, 4th Artillery.*
A. B. Dyer, *1st Lieutenant, 4th Artillery.*
M. P. Miller, *Major, 5th Artillery.*
J. McClellan, *1st Lieutenant. 5th Artillery.*

On page 8 of this Report of the Council a recapitualtion is given of the measures which the Council believed should be enacted into laws. Viewed in the light of succeeding events, these recommendations were quite prophetic, as all but the fifth, referring to the double line of second lieutenants, have been adopted in one way or another.

The suggestions of the council have also met with equal success. The system of target practice established in the Division of the Atlantic by General Schofield was approved, and it was recommended that Article XXXVIII of the Army Regulations of 1881, concerning the entire administration of the artillery, be modified so as to embrace the views of the council thus expressed. With some minor exceptions, this has been done, as it was sure to be, once the artillery had a chief.

In March, 1898, the two regiments asked for were organized, and in the following year two more batteries were added to each regiment.

In February, 1901, the regimental organization of the artillery was discontinued, and the artillery was formed into a Corps with one of the Colonels, to be selected by the President, as Chief of Artillery. Two years later, February, 1903, the Chief of Artillery was given the rank of Brigadier General. In January, 1907, the field artillery was separated from the coast artillery, and in July, 1916, the Chief of artillery was given the rank of Major General.

No doubt all of these changes were considered salutary by those who carried them through, but to the writer nothing affecting the artillery could have been more injurious to its esprit de corps than the abolition of the old regiments, and the loss of idenity of the old batteries, with their long list of distinguished commanders, bloody battles, and other glorious achievements, dating back, in one instance at least (F. 4th Artillery, commanded by Alexander Hamilton) to the War of the Revolution. The main reason for this dramatic and ill-advised change was to simplify and speed up the administration by dealing directly with post and battery commanders and ignoring the regimental commanders, as if that hadn't always been done in most respects.

A regimental organization is indispensable to the proper command and administration of line troops and the identification and preservation of their military history. The coast artillery has been used as infantry on several occasions since the regiments were abolished but it has been necessary, whenever used except by batteries, to form battalions or regiments, which is proof enough of what should be done.

One point brought out so clearly by General Hunt that further argument would be mere repetition is the absorption of the technical duties of the artillery, in so far as they refer to guns of all descriptions, their carriages, and their ammunition. The selection of these should devolve on the artillery exclusively. Their manufacture may be by anyone to whom contracts may be awarded by the Government. No corps of the army is now established on a more scientific basis than the artillery, due to the intelligence, the education, and practical experience of its officers, those from other sources than the Military Academy not excepted.

To permit a corps where duties are largely of a theoretical and sedentary nature, to decide qualities so absolutely dependent on practical knowledge or skill, which the artillery alone possesses, is to deprive the government of the only efficient means at its disposal wherewith to establish an armament adapted to all the requirements of the artillery service, and able to cope successfully with the artillery of any other army in the world.

The artillery is again demonstrating its vast importance on the battlefields of Europe, and is being used in a way never heretofore dreamed of. It numbers thousands of exceptionally fine soldiers, the very flower of the armies, and it is time that the personnel of the artillery of the United States should be privileged, as is the case in all other armies, to select the material upon which their reputation and possibly the very fate of battles may depend. That the hour may soon strike when the artillery shall come into its own in all respects, more especially the scientific duties upon which its efficiency and superiority depend, is the hope of all those who have the interests of the army at heart.

And if every artillery officer will give this subject his earnest attention, and the corps is fortunate in the selection of a wise and militant chief, determined to insist on measures so absolutely vital, and to fight for their adoption if necessary, the rehabilitation of the artillery, and thereby its elevation to the high standard of all other modern armies, will surely follow. In this connection the re-establishment of the "Department of Artillery" at West Point, in the place of the Department of Ordnance and Gunnery" would go far towards this achievement, by putting an end to a misnomer and thereby giving to the graduates of the Academy a more correct and vivid idea of the legitimate duties, and the great importance of the artillery.

"Camp Gordon Plan"

By G. B. Perkins, Capt., U. S. A.,
Chief, Military Morale Section

From out the melting pot of America's admixture of races is being poured a new American—a soldier man who, wearing the khaki and covered with the dust of the parade ground, is stepping forth into the ranks—file upon file of him—to make the world safe for Democracy, to tear the bloody hand of the Hun from the throat of civilization.

He is the "Non-English speaking soldier," who, along with his American-born brothers, has been selected through the draft to drive the overseas barbarians back into their lair.

And the wonder of it all is that but a scant three months ago it seemed that from this melting pot could be poured only a conglomerate mass of humanity, confused by a babel of tongues and disfigured by the all but shapeless mold into which it had been poured.

Yet now the mold is molding smoothly, symetrically. Soldier after soldier is being turned out fit and eager to fight for Liberty under the Stars and Stripes, mindful of the traditions of his race and the land of his nativity and conscious of the principles for which he is fighting.

And it has all been brought about by what is known in army circles as the "Camp Gordon plan"—whereby hangs a Twentieth Century wonder story; a story to make the pulse quicken in these days when every mite contributed toward the winning of this world-war is an occasion for rejoicing; a story to gladden and reassure the anxious hearts of the foreign-born within our gates who have seen their sons taken by Uncle Sam and who in agony of soul have been wondering what he will do with them.

Above all, the story of a welding of diverse nationalities into a composite American type such as the so-called "melting pot" failed to pour forth in time of peace.

When the operations of the selective draft law began to turn its chosen men into the big Army camps, hundreds and then thousands of foreign-born males who came within its scope were found in the long lines admitted. Italians, Poles, Russians, Russian Jews, Lithuanians and Greeks marched side by side with the native-born son of America. Armenians, Albanians, Syrians, Czecho-Slovaks, Jugo-Slavs, Scandinavians, Finns and even Turks answered this peremptory call to the colors. And not more than one in a hundred of them knew the English language well enough to understand the instructions necessary to make them first-class fighting men.

So, naturally, in the imperative haste of getting an Army to France at the earliest possible date, these men of stalwart frame, of flashing eye and sealed lips were pushed aside, separated from the English-speaking draftees and placed together, a conglomerate mass, in a single section of each camp in what have since been designated as Development Battalions.

And there, perforce, they were left to themselves for a while—not by choice of those in authority but simply because they presented a problem for which the answer could not be found on the spur of the moment. They were not neglected; on the contrary, they were well-housed, well-fed, well taken care of. But they were not immediately subjected to the soldier-making process to which the American-born draftees were introduced.

There were officers who could talk to some of them in their own tongues—but the officers were few, the tongues many and the men themselves thousands upon thousands. What to do with them, how to train them, how even to make them understand the few simple rules that any body of men living together must observe for the sake of mere cleanliness and good health—these were only a few of the salient points of the great problem faced by the military.

Here, let us say, was an Italian officer with some five hundred men under his command; he could make the Italians understand his orders, but the remainder of the five hundred were perhaps, of as many as forty-six different nationalities! And there, again, was a Polish officer who could speak with the Poles and the Russians, but his instructions were worse than "Greek" to the Italians, the Syrians and the rest of the men in his command. And, remember, Army officers who speak even one of these strange European tongues were so few that they were absolutely lost in the vast hordes pouring into the camps.

So, for week after week, these foreign-born draftees drifted along. They grew discontented, restless, resentful, sullen, Many of them already were trained soldiers, who had served in the armies of their native lands and, more to the point, they had answered the call to the colors with enthusiasm because they saw in it a chance to fight not only the battles of their adopted country but likewise opportunity to avenge some of the wrongs perpetrated upon their own countrymen in the past by the unholy Hun, the treacherous Austrian and the "unspeakable Turk." They had come into camp ready to fight, not to lie around and grow discontented and lazy as part of a badly disciplined rabble.

In their ranks were men who did not want to fight; men who actually did not understand why they had been put into a military camp; men who were victims of pacifist and German propaganda; men who refused to be naturalized, refused to don a uniform, refused to even pick up a rifle and learn to drill.

Presently, race began to quarrel and bicker with race; old scores from the pages of history were dug up and reopened; and even within groups of men of the same race, factions—based upon politics or religion or upon some one of many points of difference the American mind simply cannot grasp—factions began to spring up and disrupt the scant harmony that did exist.

The problem became imminently terrible. Every effort was being made to solve it; and results were being obtained here and there, but not on the big scale necessary. The few officers equipped to handle portions of the mass worked day and night to bring some sort of order out of the chaos. But sheer force of numbers neutralized their valiant efforts.

Then came to the fore two officers with a plan which they believed would solve the problem, a plan so simple that now it seems it should have been obvious; but then indeed a plan which possessed all the elements of novelty and uncertainty.

This plan of theirs was to segregate according to their nationalities the foreign speaking soldiers who could not understand commands, army orders and regulations in English. Instead of Poles, Russians, Italians and a dozen other races being jumbled, helter-skelter, into one battalion, they advised, the Poles should be formed into all-Polish companies and battalions; and so, too, with the Italians, the Russians and the other races.

A simple plan? Indeed yes—looking backward! But not quite so simple as it seems, even now. Its advantages were many; the obstacles to its execution all but legion. For example, to officer an all-Italian company the officers need be able to speak only Italian and English. But where were such officers, trained and capable, to be found? And, obviously, to find officers competent to command companies and battalions formed of every nationality present was an impossible task. So, there must be some officers who knew not only one language in addition to English, but many dialects and—more than all else—knew the characteristics and idiosyncracies of the Jugo-Slavs, Czecho-Slovaks, Syrians, Armenians and other races. Where, again, could such men be found? They certainly were not in the old U. S. Army.

But the officers were not deterred by such obstacles. They decided to go ahead, with the proper authorization, and let each day be sufficient unto itself.

Camp Gordon, an Infantry Replacement camp near Atlanta, Georgia, was the place selected for the experiment on a big scale. There were some four thousand non-English speaking soldiers there who were all but running around in circles. Indeed, many of them were openly indifferent, discouraged, discontented, rebellious. Not understanding English, many of them were confined to kitchen and police duty working with pick and shovel; and they were objects of ridicule for the English-speaking soldier who derived keen pleasure in calling them "Wops" and "Sheenies" and other terms of goodnatured comtempt. But few of them had been naturalized.

Many who truly hated the Central Powers were being held as enemy aliens solely because, not being understood, they gave the impression of being such. Others were out-and-out adherents of Bolshevik principles. Many were discontented because of their enforced isolation from spiritual and religious stimulus, believing that services at the Knights of Columbus Huts were not Catholic because they were not Polish or Italian. Still others were real yellow dogs of the pacifist breed. And a large number were physically unfit for active duty and were cluttering up hospital facilities when they might have been transferred elsewhere or discharged from service.

Into such a problem our officer sailed in two-fisted fashion, with co-operation from Washington. And he conceived the amazing idea of handling this "army neglected and ignored" not en masse but individually! He did it, too. One by one the men were called before him and questioned. In several days he actually talked separately to 976 men! And spoke to them in either their own respective languages or in a combination of dialects—at all events he made them understand; and he, in turn, understood them! Thousands of complaints were noted, classified and either explained or adjusted. Each man was classified as to his nationality, loyalty, intellect, citizenship and fitness for military service.

A little pen-picture of what occured (in various diverse forms) during this gigantic process of individual examination:–

The Lieutenant, tall, fair-haired, boyish dispite his close-cropped mustache, slender, alert of eye and mein is seated at a bench in one corner of a mess-hall. Ranged down the sides of the room are the men in line—some of them plainly fearful of what new ordeal they are to face, others sullenly belligerent, most of them stupidly resigned to whatever may come.

It is the turn of a young Russian, let us say, at the head of the line, to step before the Lieutenant. He makes no effort to salute in even imperfect fashion; he just stands and stares at his feet, at the floor, at the walls—anywhere except into the searching, steel-blue eyes of the officer.

"Your name?" says the Lieutenant.

He gives it—sullenly. He has refused to drill, to put on a uniform, to sign his naturalization papers. He is a pacifist.

"You do not believe in fighting—in force? You are not willing to be a soldier?" asks the Lieutenant.

He does not. Never—never should physical force be used. He cannot bear even the thought of killing a man.

"Ah! Never? You have a sister—yes? And she is still in Russia—yes? Suppose, my peaceful friend, you saw a German soldier rush upon her to assault her—what would you do? Would you use force—would you try to kill him even if you died yourself in the attempt?"

The Russian—magnificent of body, steady of eye—breathes hard and, despite his apparent effort to the contrary, hangs his head. No! He would not use force; he would not kill the German brute.

"What—would—you—do?" Slowly, word by word, with an interval between each of them, in a voice cold as steel the Lieutenant makes his inquiry.

The man shifts his weight from one foot to the other. He fumbles with his hat, he tugs at his collar. Then he answers.

He—he would try to reason with the Hun beast! He would endeavor to persuade him that he was doing a foul deed!

"So!" The Lieutenant has sprung to his feet, his eyes are ablaze with wrath and disgust, his arm is outstretched, accusing finger levelled in scorn at the miserable creature before him. "So! You would! Then you are nothing but a coward! A cowardly dog! You are afraid to fight! You are pretending all this because you are afraid to face German bullets! Afraid to do your part in avenging the wrongs German soldiers have done to your native land—to other men's sisters there! You dare not risk your own skin! You are not a man! You are just a coward! That is all that's the matter with you!"

The Russian is now transformed. He, too, is alive with wrath. His eyes also are ablaze with anger. "I am not! I am not a coward!" he shouts. "I want to fight! I would kill a man who treated my sister— but—but—!" And he breaks off, the tears streaming down his cheeks.

"But what—my friend?" asks the Lieutenant quietly. "Tell me. Tell me where you got this idea of being a pacifist? Who has been preaching it to you? Tell me what is troubling you. I want to be your friend, to help you—but you must be a good soldier, you must obey my orders—you must be a man! Tell me!"

And the man does. He really wants to fight. He was a soldier before he came to this country. He hates the Hun. But he is worried about his wife and child whom he left at home —in New York, maybe. What will become of them? He hasn't heard from them. How will they live? Will they starve while he is at war? And he has heard certain of his comrades talk about this thing called pacifism and "Conscientious Objector"—and they have told him that it will be the means of getting him out of the army so he can return to his wife and child.

Then the Lieutenant smiles—encouragingly, confidently, and takes him by the elbow.

"Listen, my friend," he says. "That is because you do not know. Haven't you heard yet that—" And quickly, but in detail, he explains how Uncle Sam will care for his wife and child while he is at war—how a part of his monthly pay will be deducted and an equal amount added by the Government and the whole then sent to the good wife. He tells him all about the allowance and allotment plan, and about Government insurance and the various other ways by which the wife and child will be helped along by civilian organizations.

Result:—Another good soldier for Uncle Sam, satisfied, relieved of his worry, eager to serve.

"Next" cries the Lieutenant.

And so it goes.

The above is but one instance. They are legion, as are the issues involved.

Here a man is unruly because he doesn't want to drill and pretends to be suffering from rheumatism. If real, his complaint is given careful treatment and he is not asked to drill until fit to do so.

There another is unwilling solely because he does not understand why he is to be made a soldier—actually does not know why we are at war. The officer explains it all to him, how he was fairly selected in the draft, how he will be well treated by Uncle Sam, how he now has an opportunity to prove himself worthy of his ancestors, to avenge the wrongs perpetrated upon them in the past, to play the part of an honored citizen of the new land of his adoption. And the man goes out a better man than when he came in—and a willing soldier of the United States.

In general, most of the objections to service are due to a lack of knowledge of the English language. Seventy-five per cent of the men, though in camps since last fall had, up to a short while ago, neither learned English nor the rudiments of being a soldier. But their troubles and complaints dissolve almost as the proverbial morning mists once they have an opportunity to talk with an officer, who can explain broad American principles and answer their questions.

This classification at Camp Gordon resulted in the formation of three groups, as follows:-

1. Development Battalion, composed of all physically fit men.
2. Labor Battalion, comprising the really disloyal and enemy aliens.
3. Non-Combatant Service, composed of the physically unfit for overseas service but proficient in some trade.

Straightway the physically fit were assigned to what was known as the Second Development Battalion and two companies were formed, one composed of Slavs (the majority of them Poles) and the other a company of pure-blooded Italians; and each company averaged, including men and officers, 258 in personnel. Three officers of Polish extraction and one of Russian were secured, for the Slav company; and two officers of Italian extraction for the Italian company, so that the men might be instructed in their native tongues. One officer of Greek extraction was also obtained to handle the Greeks.

The first week was devoted to lecturing on discipline and the Articles of War and to preliminary military training. Straightway fifty per cent of the discontent disappeared, and real enthusiasm was evident.

And presently, too, another factor became apparent, a most desirable factor. For example, said one of the soldiers in the Slav company to one of the soldiers from the Italian company, "You Italians aren't real soldiers, we are!"

The Italian's eyes narrowed to gimlet-points. "Sapristi! Is that so! Well you just watch us drill! You Slavs can't even march!"

And that started the ball rolling. Each company tried to out-drill the other.

Result:—both companies developed faster than the average American company of recruits would develop, normally—and the infection spread throughout all the foreign-speaking soldiers in camp.

To depict every step in this vast development scheme—how other units were formed and are still being formed—would be burdensome. But results at least verify the correctness of these steps. So, consider the fact that after four weeks of intensive training the companies of this Second Development Battalion were reviewed in close order drill by the Commanding General of Camp Gordon and his staff, who were highly pleased at the showing.

A few days later these same companies were inspected by an officer of the General Staff from Washington who, after expressing himself as impressed by their work, lined up the Slav company and asked: "How many of you men are ready to go abroad immediately? Those who are, step forward two paces." In response, ninety-two per cent of the Slavs who a short while before had refused to go overseas stepped forward with spirit and enthusiasm. (Italians were not asked this question as they are known to be loyal because Italy herself is our Ally).

And a little while later three hundred men were selected from this Second Development Battalion and recommended to be sent to Replacement regiments as fit for overseas service as a unit!

Really to appreciate the tremendous problem of the foreign-speaking soldier and to realize that a complete solution has almost been reached, one should observe him at work in the camp, see him covered with the dust of the parade ground, smell the very sweat of him! He drills—the best type, that is—with a snap and a go that bespeak the born soldier. Big of frame and strong of muscle he is truly a glutton for work. Once he fully understands why he is there, why we are at war and what we (including himself) are fighting for, he tackles the job of becoming a soldier with determination.

Watch him in "school" each day. See how hard he labors to learn the English alphabet, then words, then sentences. Note the zeal with which he follows the instructors, non-commissioned men who speak his own language and good English, too.

The letters of the English alphabet are written large on a huge blackboard and pronounced over and over again so their "sound" becomes fixed in the ear. Then the class recites them in unison, then individually; then the instructor skips about the alphabet with his long pointer and the individual tries to call the letters correctly.

Recently the writer visited such a school. One man called off the letters perfectly, missing not a single one though the instructor pointed them out in every way calculated to confuse him.

"So!" said the instructor dramatically to the rest of the class of Italians after the man had successfully survived the test, "He pack it all in his nut—why you no do the same!"

Then come words—nouns, verbs, adjectives. "I write"—"I wrote"—"I will write"—and they have the elementary principles of the tenses of English grammar. Broad shoulders and touselled heads bend determinedly over strong hands that grip stubs of pencils which slowly trace out on thick pads of paper words and sentences to be examined and marked later by the instructor. And they work hard at it!

Watch them, too at the moving picture Y.M.C.A. and K. of C. Huts in the evening when their work is over. The non-English speaking soldier loves the movies. There on the running screen he reads a language he understands instantly. But his officers also either translate the English "readers" for him or explains them in more simple English in order that he may understand the film completely.

See him at mess—eating a man's-sized meal after a day of man's-sized work—with food that is plentiful, appetizing and of the best quality. Observe the inherent good nature of him in leisure moments in barracks, and note his stern attention to duty when he is doing sentry duty at night around his company street.

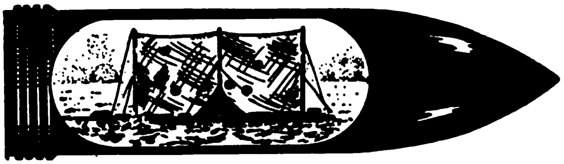
Verily, you see a soldier—the best type of soldier—in the making!

There are thousands and thousands of Non-English-speaking soldiers in our Army camps, and thousands more will arrive with the coming drafts. We know what to do with them now, how to weed out the tares from the wheat, how to reach after the best in the heart of the alien soldier and develop it, how to loosen his tongue and to teach him the principles of American citizenship. And we know, too, that he will respond to such treatment!

We know that this so-called "Camp Gordon plan" is the one which will add thousands and thousands of virile, efficient soldiers to our armies on the battle lines.

Yet there is nothing magical about it. It is just plain common sense. And it meets the approval of the non-English speaking soldier himself. It can be done at any camp in the country—and will be wherever necessary. Already it is operating in several other camps, and each time more successfully than before.

And, presently long lines of soldier-graduates of the "Camp Gordon plan"—no longer entirely non-English speaking, no longer aliens—will be marching from the camp to the train, to the boat, to the battlefield conscious of the best traditions of their native lands and firmly convinced of the justice of the cause of the land of their adoption, fit and eager to fight her battles and thereby save all humanity from the scourge of a race gone mad with the lust for world-conquest. Truly, the non-English speaking soldier of foreign extraction is to be an important part of Pershing's Crusaders.



Artillery Co-ordinate Computation Charts

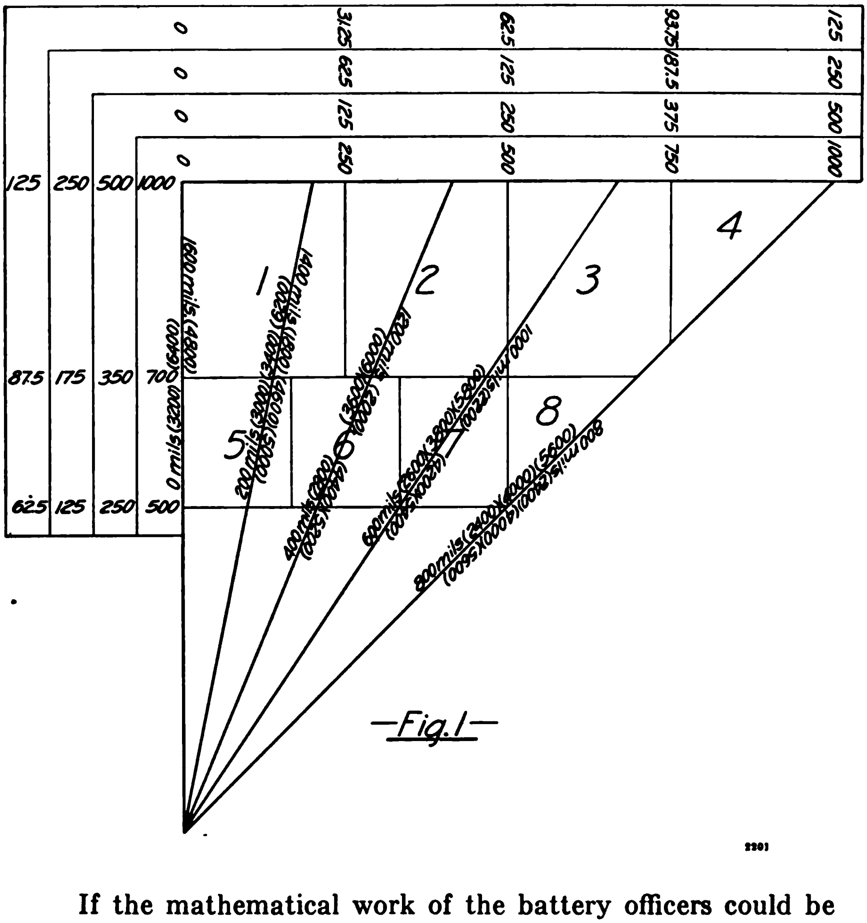
By Captain S. H. Simpson, Headquarters, 37th Art. Brigade

At the present time the majority of the ballistic calculations for the Heavy Artillery are made by the use of charts. Corrections for both the lateral and longitudinal effect of the wind are made from a chart. Atmospheric corrections for pressure and temperature are made by chart. The temperature of the powder and in fact practically all corrections that cannot be taken from the range table, except range and direction, are computed either by charts or require nothing but the simplest arithmetic. If the trigonometric calculations involving co-ordinates, Y-azimuth, and range could be computed, by a method equally simple a battery sheet, a traverse, an intersection problem or a resection problem could be handled complete by an intelligent non-commissioned officer who knew nothing of trigonometry and logarithms.

The importance of such a step as this cannot be too strongly emphasized. All work connected with firing should invariably be checked independently by two persons. If the methods are sufficiently simple the calculations can be made by a non-commissioned officer and checked by an officer, or vice-versa, thereby saving the time of one officer. In cases of emergency it may often happen that only one officer is available and yet the required check could be made.

An Orientation Officer may not always be able to secure a detail among whom is a man who has sufficient mathematical ability to handle the trigònometric solution of the various orientation problems. Yet if the work could be done by charts that his men could handle he could hand over his data to the tactical commanders, completely checked and with confidence in its accuracy. The difficulty of getting an Orientation Detail with men of mathematical ability is a real one. The great demand for officers has resulted in sending to the Officer's Training Camps almost all the men who can handle trigonometry.

With the present trigonometric method of calculating firing data it has been necessary to eliminate much good officer material from competition for commissions, and it probably has been necessary to commission as officers many men with mathematical training but without other officer qualifications that would be considered sufficient if the need for officers were not so urgent.

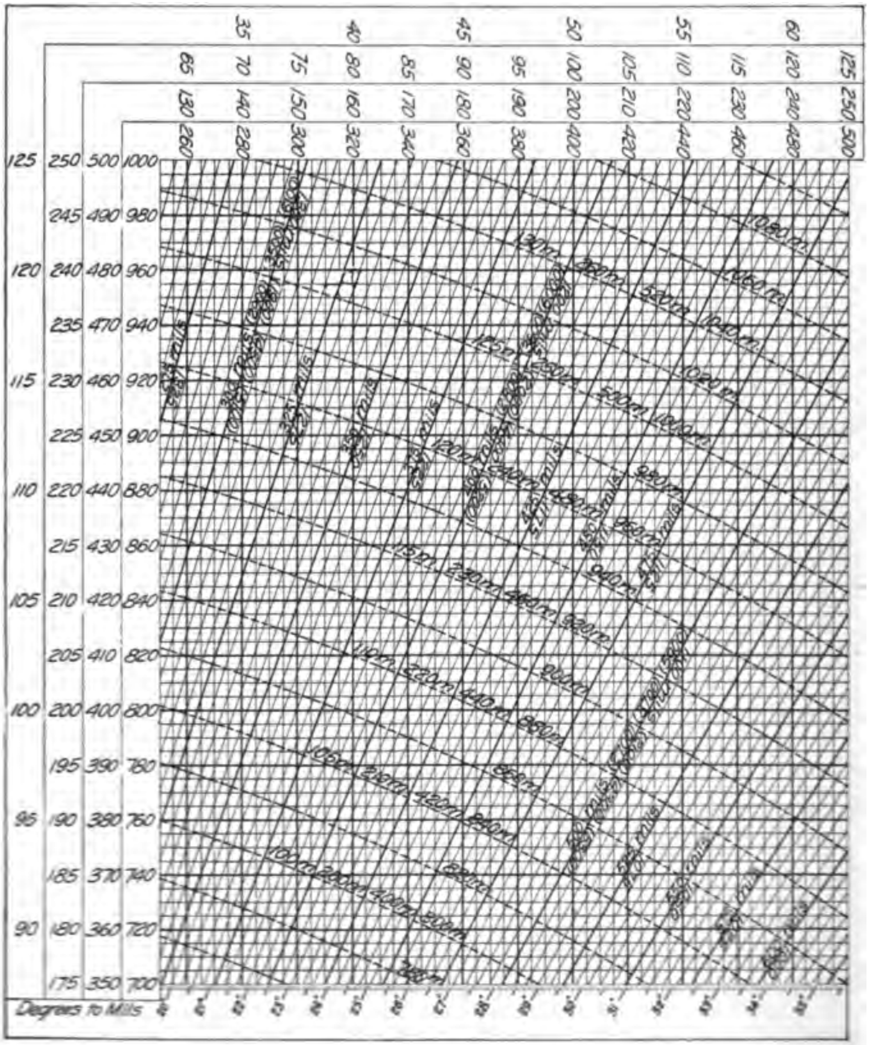

0
31.25
62.5
93.75
125
0
62.5
125
187.5
250
0
125
250
375
500
0
250
500
750
1000
125
250
500
1000
87.5
175
350
700
62.5
125
250
500
1
2
3
4
5
6
7
8
1600 mils (4800)
0 mils (3200)(6400)
1400 mils (1800)(4600)(5000)
200 mils (3000)(3400)(6200)
1200 mils (2000)(4400)(5200)
400 mils (2800)(3600)(6000)
1000 mils (2200)(4200)(5400)
600 mils (2600)(3800)(5800)
800 mils (2400)(4000)(5600)
800 mils (2400)(4000)(5600)

—Fig. 1—

If the mathematical work of the battery officers could be simplified to plain every day arithmetic and the use of charts, this situation could, to a large extent, be relieved. It is with this idea largely in mind, as well as shortening the time required for computations that the Artillery Co-ordinate Computation-Charts are brought forward.

The charts are in reality nothing more than a device for solving the elements of right triangles. There are four variables,—the two sides of the right angle, the hypotenuse and one of the acute angles. Any two of these being known the other two can be read from the charts.

The chart is constructed with four borders for the purpose of saving space. Each border represents in reality a separate



—Fig. 2—

art drawn on a different scale. How this works out can be tter seen from the instructions given later.

There are eight charts or pages used to cover all the combinations of numbers and angles. In reality they are merely eight sections of one shart, cut apart for convenience. Four of these are on one scale and four on onother in order that the angles may be read with about the same degree of accuracy. One of the charts is reproduced on a small scale with this article. (See Fig. 2). On it the angles can be read quite readily to a half mil and distances on the smallest scale or inner border to a half meter. On the full size charts which fit an ardinary 9″ x12″ loose leaf note book, the angles can be read to a quarter of a mil and distances to a quarter of a meter without difficulty. If still greater accuracy is desired still larger charts could readily be made.

Fig. 1 shows how the big chart was cut into eight pages of which Fig. 2 is page 2. It was found convenient to make pages 1, 2, 3, and 4 on a scale of 8 cm. to 100 meters on the inner or smaller scale and pages 5, 6, 7, and 8 on a scale of 12 cm. to 100 meters. By using these scales it will be found that distances between the graduations on the chart can be scaled off with the ordinary triangular boxwood metric scale.
pages 1, 2, 3, and 4 on a scale of 8cm. to 100 meters. By using these scales it will be found that distances between the graduations of the chart can be scaled of with the ordinary triangular boxwood metric scale.

If so desired the charts can be used for reading distances when the mil angle of objects of a known size is measured, for reading natural functions of mil angles, for converting mils to degrees, etc.

INSTRUCTIONS

When the terms d_x and d_y are used they represent respectively the difference in the x and y co-ordinates of the two points in question.

Y-bearing is the acute angle in question made by a line with the Y-axis.

When d_y is greater than d_x the Y-bearing is less than 800 mils. Conversely when d_x is greater than d_y the Y-bearing is greater than 800 mils and less than 1600 mils.

When d_y is greater or when the Y-bearing is less than 800 mils, hold the chart with the long side vertical.

If d_x and d_y are given and the distance and Y-azimuth are required find d_y on the upright scale and d_x *in the same border* on the scale at the top of the chart. The intersection is the point to be read. Interpolate between the diagonals or mil rays. Read the figures on the upper left side of these rays. They represent the Y-bearing which is the same as the Y-azimuth in the first quadrant. On each 100 mil ray the corresponding Y-azimuth for the bearing in each quadrant is given within the parenthesis. The mil rays are graduated for distance. Each graduation represents four distances corresponding with the four borders. The distance at the right is used when the inner border is used and so on.

When the distance and angle are given the process is reversed.

When d_x is greater than d_y the chart is merely turned around with the short side upright. The d_y is always read on the scale that is upright. The mil angles are now read from the figures on the other side of the mil rays, the figures being on the upper right hand side of the rays with the chart in this position. Otherwise proceed as when d_y was greater.

DATA NECESSARY FOR MAKING CHARTS

As an aid to the construction of a set of charts as described there are given in the attached list the results of all the necessary computations. The computations are made for each 10 mil ray. The intermediate 5 mil rays may be interpolated.

The computations are based on the scale of the inner border.

The first column gives the mil ray.

The second column gives the d_x at which the ray cuts the upper border of pages 1, 2, 3, and 4 when the long side of the page is vertical.

The third column gives the d_x at which the same ray cuts the lower border of pages 1, 2, 3, and 4 which same figure is used in plotting the points where the rays cut the upper border of pages 5, 6, 7, and 8.

The fourth column gives the d_x at the lower border of pages 5, 6, 7, and 8.

The fifth column gives the length of the ray from the origin to the point where it cuts the 700 line on the inner scale which is at once the bottom of pages 1, 2, 3, and 4 and top of pages 5, 6, 7, and 8. If a scale is so placed on the ray that this value on the scale coincides with the 700 line on the chart the ray can be graduated direct from the scale.

The mil rays can be drawn by plotting the points where each ray cuts the upper and lower borders of the page and then connecting the points. In case a ray cuts either the upper or lower border but not both on the same page, place the two adjoining pages together in their proper relative positions and then draw in the rays.

Mils	D_x at which ray cuts			Distance on Ray from zero to Line 700	Mils	D_x at which ray cuts			Distance on Ray from zero to Line 700
	Line 1000	Line 700	Line 500			Line 1000	Line 700	Line 500	
10	9.8	6.9	4.9	700.0	410	425.8	298.0	212.9	760.8
20	19.6	13.7	9.8	700.1	420	437.4	306.2	218.7	764.0
30	29.5	20.6	14.7	700.3	430	449.2	314.4	224.6	767.4
40	39.3	27.5	19.6	700.5	440	461.0	322.7	230.5	770.8
50	49.1	34.4	24.6	700.8	450	473.0	331.1	236.5	774.3
60	59.0	41.3	29.5	701.2	460	485.0	339.5	242.5	778.0
70	68.8	48.2	34.4	701.6	470	497.2	348.1	248.6	781.8
80	78.7	55.1	39.4	702.1	480	509.5	356.7	254.8	785.6
90	88.6	62.0	44.3	702.7	490	522.0	365.4	261.0	789.6
100	98.5	68.9	49.2	703.4	500	534.5	374.2	267.3	793.7
110	108.4	75.9	54.2	704.1	510	547.2	383.0	273.6	798.0
120	118.4	82.9	59.2	704.9	520	560.0	392.0	280.0	802.3
130	128.3	89.8	64.2	705.7	530	573.0	401.1	286.5	806.8
140	138.3	96.8	69.2	706.6	540	586.1	410.3	293.1	811.4
150	148.3	103.8	74.2	707.6	550	599.4	419.6	299.7	816.1
160	158.4	110.9	79.2	708.7	560	612.8	429.0	306.4	821.0
170	168.5	117.9	84.2	709.9	570	626.4	438.5	313.2	826.0
180	178.6	125.0	89.3	711.1	580	640.1	448.1	320.1	831.2
190	188.7	132.1	94.4	712.4	590	654.1	457.8	327.0	836.4
200	198.9	139.2	99.5	713.7	600	668.2	467.7	334.1	841.9
210	209.1	146.4	104.6	715.1	610	682.5	477.7	341.2	847.5
220	219.4	153.6	109.7	716.7	620	697.0	487.9	348.5	853.2
230	229.7	160.8	114.9	718.2	630	711.7	498.2	355.8	859.2
240	240.1	168.1	120.1	719.9	640	726.5	508.6	363.3	865.3
250	250.5	175.3	125.2	721.6	650	741.7	519.2	370.8	871.5
260	260.9	182.7	130.5	723.4	660	757.0	529.9	378.5	877.9
270	271.5	190.0	135.7	725.3	670	772.5	540.8	386.3	884.6
280	282.0	197.4	141.0	727.3	680	788.3	551.8	394.2	891.4
290	292.7	204.9	146.3	729.4	690	804.4	563.1	402.2	898.4
300	303.4	212.3	151.7	731.5	700	820.7	574.5	410.3	905.5
310	314.1	219.9	157.1	733.7	710	837.2	586.1	418.6	913.0
320	324.9	227.4	162.5	736.0	720	854.1	597.9	427.0	920.6
330	335.8	235.1	167.9	738.4	730	871.2	609.9	435.6	928.4
340	346.8	242.7	173.4	740.9	740	888.6	622.0	444.3	936.5
350	357.8	250.5	178.9	743.5	750	906.3	634.4	453.2	944.7
360	368.9	258.2	184.5	746.1	760	924.4	647.1	462.2	953.3
370	380.1	266.1	190.1	748.9	770	942.8	659.9	471.4	962.0
380	391.4	274.0	195.7	751.7	780	961.5	673.0	480.7	971.1
390	402.8	281.9	201.4	754.6	790	980.5	686.4	490.3	980.4
400	414.2	289.9	207.1	757.7	800	1000.0	700.0	500.0	989.9

Probability Chart

By Captain George E. Shipway, C. A.

As the various Gunnery Problems involving the use of Probabilities are numerous and as their solution is so tedious and slow, owing to the many tables that must be consulted and the many interpolations in these tables that are necessary, the accompanying chart has been devised.

The use of this Probability Chart is quite simple and it is believed large saving of time may be effected thereby. Its accuracy in the case of Example I, beneath, is 1 in 200; and in the case of Example II—1 in 5000, its accuracy depending largely upon the accuracy of the operator. The time taken to work out example I should not be greater than 2½ to 3 minutes while the solution of this problem by tables requires from 20 to 40 minutes. The time for solving problem II by the chart should not be greater than 3 minutes while solution by tables requires from 30 minutes to an hour. Errors in calculation are largely eliminated by its use. The following examples have been selected with a view of demonstrating the use of the table in every way rather than with an idea of presenting practical problems to the operator.

Example I—Given a target 65 meters by 30 meters lying on a 10% direct slope, length of target parallel to the direction of fire, at a range of 10,100 meters, using a 155 mm. G.P.F. rifle, M.V. 596 m/s (charge 8.85 kg.) the target requiring six direct hits to destroy it. Determine *theoretically* how many rounds must be provided, in addition to those required for adjustment, to destroy the target.

Interpolate between the 10,000 and 11,000 range lines (B) on the 8.85 kg. side of the chart for a line representing a range of 10,100 meters. Find the intersection of this line and the 10% direct slope curve (E). Project this point down to the theoretical P. E. Line (F) and lay a straight-edge horizontally across the chart at this point. On the scale thus obtained, plot points 32½ meters each side of the center line; project these points downward and note their intercept on the ladder of scale (A) beneath at 14½% on each side. The included longitudinal probability is therefore .29.

Interpolate on the lateral scale between the 10,000 and the 11,000 range lines for the 10,100 meter range line. Plot on this line by the theoretical scale beneath two points 30 meters apart, and 15 meters each side of the center. Read the included percentages indicated by the curved lines. These percentages we find to be 41% each side of the center line or total lateral probability .82.

Multiply the longitudinal and lateral probabilities (.29 × .82) and the result (about .24) is the probability of hitting, both dispersions being considered. To find the number of rounds required, solve the equation $\frac{x}{6} = \frac{100}{24}$ or $x = 25$, the answer desired.

Example II—Given a target 40 meters by 25 meters lying on a 7½° direct slope at a range 13,300 meters, target lying lengthwise in the direction of fire, using a 155 mm. G.P.F. rifle, M. V. 735 m/s (charge 11.8 kg.). Because of the proximity of friendly troops it is necessary to place our center of impact 120 meters beyond the further edge of the target and 30 meters to the right of the right hand edge of the target. How many hits may we expect, *practically*, after adjustment, if 1500 rounds are fired?

Interpolate between the 13,000 and 14,000 range lines, (P) under charge 11.5 kg., find and draw the 13,300 meter range line. Find the 5° and 10° direct slope curves and interpolate between them on the 13,300 meter lines for 7½°. Project this point down to the practical probable error line (G). At this point lay a straight-edge horizontally across the chart and plot two points, one 120 meters from the center line (the C.I. line), and the other 40 meters beyond the first point. Project these points downward to the ladder (A) and note the intercepted percentages. The first point intercepting at 30% and the second at 37¼%; the included percentage (their difference) 7¼% is the longitudinal probability.

On the Lateral Scale find and draw the 13,300 meter range line by interpolating between the 13,000 and 14,000 range lines. Plot two points on this line using the practical scale beneath; the first 30 meters from the center and the second 25 meters beyond the first. Read the included percentage indicated by the curved lines, finding one point outside of the 49½% line and the other at 46%. The included 3½% is the lateral probability.

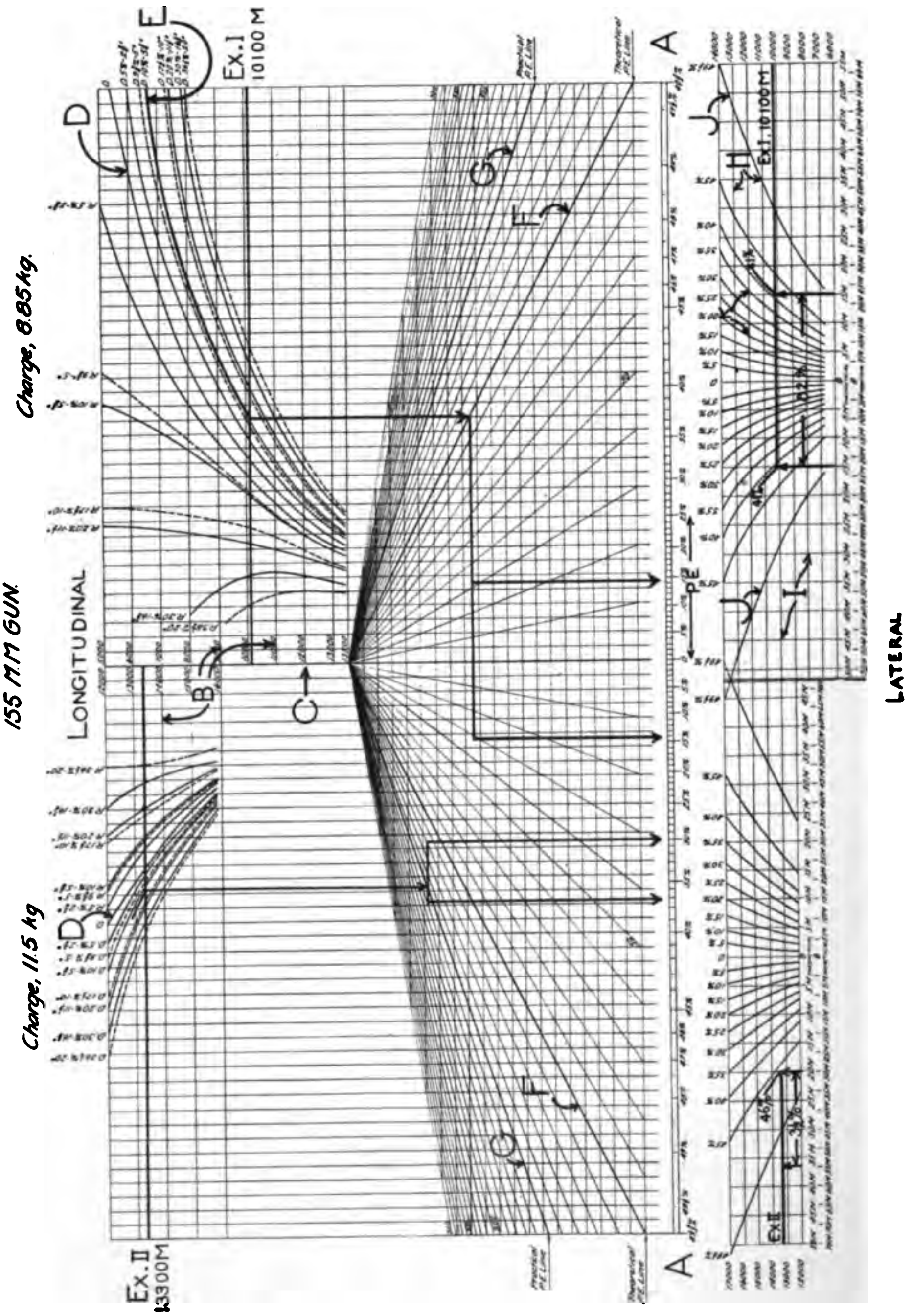

155 M.M. GUN.
Charge, 8.85 kg.
Charge, 11.5 kg
LONGITUDINAL
LATERAL
Ex. I
10100 M
Ex. II
13300 M
Ex. I. 10100 M
Ex. II
A
A
B
C
D
D
E
F
F
G
G
H
I
J
J
PE
Practical
Theoretical

Fig. 1.

Multiply the longitudinal and lateral probabilities (.0725 × .035) and the result (.0025) is the probability of hitting, both dispersions being considered.

To find the number of shots we may expect to hit the target, solve the equation $\frac{x}{1500} = \frac{25}{10{,}000}$ or $x = 3.75$, the answer desired.

CONSTRUCTION

Longitudinal Probability Scale.—A ladder of dispersion (A) is first constructed and is divided into percentages from the center or center of impact outwards in the following manner: The length of the probable error on the scale is taken at some convenient length, 50 mm. in the example, and enter the probability table (Page 209 Gunnery for Heavy Artillery) divide the figure under "Probability" by 2 obtaining a percentage and multiply the figure opposite in the "n" column by the size of the scale probable error and thus obtain the distance from the center in both directions at which the percentage is placed. For example in making up the scale we wish to obtain a position for the 8% mark; we find .1604, of which .08 is one half, and opposite the .1604 in the "n" column we find .30. We then multiply our scale P.E. of 50 mm. by .30 obtaining 15 mm. as the distance from the center of the ladder at which to place in both direction the 8% graduation.

At some distance above this ladder we draw a number of equally spaced horizontal lines (B) parallel to the ladder: From the center of the ladder of dispersion we erect a perpendicular (C) bisecting, and forming right angles with, the horizontal lines. These lines (B) we number in ranges taken 1000 meters apart. To construct the 0 slope curve (D), we then lay off distances from the perpendicular on the various range lines representing 100 meters at that range and to the scale of the ladder of dispersion beneath. Thus if the 50% zone, theoretical, for the 155 mm. gun, charge 8.85 kg., is 164 meters at 11,000 meters range the P. E. (theoretical) at that range is 82 meters and if 82 meters is represented by 50 mm. on the ladder, 100 meters would be represented by $\frac{100}{82}$ of 50 mm. or 61 mm. The proportion being x(mm.) : 100 meters :: 50 mm. : 82 meters. We then point off 61 mm. from the perpendicular on the 11,000 meter range line, on that side representing all values for the 8.85 kg. charge. We compute and point off similar scale values at the various ranges and connect these points with a smooth curve (D). On the other side of the perpendicular we point off 100 meter scale distances for the 11.8 kg. charge.

We next compute 100 meter scale distances for the various direct and reverse slopes in percentages and degrees for the various ranges, looking up the angle of fall of the particular range and charge and entering the "Coefficient of Slope" table with that angle of fall and getting therefrom the factor by which the probable error must be multiplied at a given slope; but, as our probable error remains constant on the scale, our 100 meter scale must be divided by the obtained factor to secure a new 100 meter scale for that slope. For example: if we were plotting a 10% direct slope line (E) on the 8.85 kg. charge scale and we desired to find the length of the 100 meter scale at that range and slope, we would look up in the Range Table the angle of fall at, say, 11,000 meters range and find it 588.9 mils or 33.12°. Entering the direct slope table with 33.12° by interpolation between 30° and 35° values we find a coefficient of .869 by which we divide the horizontal value found perviously for this range and charge (i.e., 61 mm.) obtaining 70.2 mm. as the 100 meter scale at that range slope and charge. We obtain similar points for different direct and reverse slopes at various ranges and connect all points of the same slope and charge with a smooth curve. It is to be noted in this computation that in order to avoid unnecessary interpolation it is best to find ranges having angles of fall in degrees corresponding to the values of the angles of fall in the tables, and for these ranges obtain a 100 meter scale and compute the various 100 meter slope scale distances.

Between the 100 meter scale and the ladder, a sheaf of lines radiating from a common center is constructed; the center is placed on the perpendicular bisector (C) of both the 100 meter scales and the ladder and the lines radiating from it are so drawn that their horizontal intercepts are equal. This is done by first drawing a line (F) from the center to a point spaced from the center the same distance as the 49⅛% graduation is from the center of the ladder. Number this line 100. Divide the distances between this line and the perpendicular into 10 equal parts; also point off equal units on the farther side of the 100 line and draw rays from the center to these points numbering every fifth line. Draw similarly spaced lines on the other side of the perpendicular, thus having equal distances on a horizontal, taken at any point, intercepted by the rays. Each intercept representing a distance of 10 meters. Now label the 100 line "Theoretical Probable Error" and as the practical probable error is one and one half times the theoretical probable error the scale distance representing 100 meters in comparison to the theoretical probable error will represent 150 in comparison to the practical probable error, and the 150 (G) rays or lines will be labeled "Practical Probable Error." If therefore, we project a distance from the center line representing 100 meters at the range charge and slope desired down to the sheaf and to its intersection with either the 100 or 150 line, depending on whether we wish to work out theoretical or practical probabilities, we have obtained, on the horizontal of this intersection, a scale divided into 10 meter distances which we may apply to the ladder beneath.

Lateral Probability Scale. As the lateral probabilities vary but little with the slope the construction is rather simpler. Assume a convenient scale; in this case 2 mm. = 1 meter in a theoretical probable error scale and 1-1/3 mm. = 1 meter in the practical probable error scale; draw parallel perpendicular line (I) spaced 10 mm. apart, numbering a central line 0, and for the theoretical scale number each line in both directions from the center line 5 meters, 10 meters, and 15 meters, etc., and for the practical scale number every second line in both directions from the center line 15 meters, 30 meters, 45 meters, etc. Lay off equi-spaced horizontal lines (H) and number these by the different ranges taken 1000 meters apart. Lay off the value of the theoretical bracket or 50% zone for the range on its range line in each direction from the center, at a distance equal to its value on the theoretical scale beneath. Join all such plotted points by a smooth curve (J). Next divide the fractional probable error spacing value of the 5%, 10%, 15%, etc., points previously obtained from the probability tables, for the construction of the longitudinal ladder, by 4. Point off on each side of the center points representing 5%, 10%, 15%, etc., at distances obtained by multiplying the scale value of the bracket by the figures thus obtained. Connect points of the same percentages by a smooth curve (K). Construct scale for both charges in a similar manner.

Notes on the Use of the Aeroplane in Coast Defense

By John Hays Hammond, Jr.

Member Board of Governors, Aero Club of America and Aerial Coast Patrol Commission; Inventor of system of Radio Control of Torpedoes and Aero-Radio System of Coast Defenses

The operations in the present war of fleets operating against coast defenses have strongly emphasized the necessity for making of revolutionary changes in our system of coast defense. That this has been appreciated by our War Department is evidenced by certain plans which have been made more or less public from time to time.

One of the most important lessons that the war has taught us is the tremendous value of the areoplane for fire control purposes. With the extreme long ranges of modern naval guns, it is well recognized that greater elevations are necessary for the fire control stations than can be secured in the topographical features of the average coast fortifications.

The war has developed immensely the mobility of artillery. It can be taken as almost an axiom that fixed artillery can always ultimately be silenced by a determined enemy, and while we shall retain the fixed defenses to protect certain important harbor entrances, nevertheless, in order to expand our defenses from a harbor defense system into that of a truly coast defense system, it will be necessary for us to employ a large quantity of mobile artillery which will preferably operate on costal railroads, with special spur tracks designed and located from entirely tactical considerations.

The problems of application of aircraft for Coast Defense resolve themselves, therefore, into two classes: (1) The employment of aircraft in connection with fixed defenses. (2) In connection with mobile artillery.

FUNCTION OF DIFFERENT TYPES OF AIRCRAFT IN COAST DEFENSE

The functions of different types of aircraft in coast defense are as follows:

(1). LAND AEROPLANES: Equipped with one, two, three and four motors. This type of craft should be used in a larger percentage than all the other types of aircraft. Single motored planes are used mainly for combat. Twin motored planes are preferred for fire control work because the extra motor permits the plane to operate even when one motor is damaged or stops. Three and four motored planes are especially adapted for going long distances with large loads of bombs, aircraft guns and torpedoes for attacking enemy ships and landing parties. With large planes it is possible to carry powerful wireless sets, capable of a range of over 500 miles, like those carried by Zeppelins.

(2). SEAPLANES: Including the hydroaeroplane and flying boat types, which are used mainly where the location of the defenses does not permit establishing a landing place within a radius of thirty (30) miles of the fort or battery, and for special work like locating mines, etc. They are not as suitable for winter conditions as the land planes.

(3).DIRIGIBLES: Good size dirigibles capable of operating in strong winds are especially useful for night operations.

(4). KITE BALLOONS: Are the aerial eyes of the man behind the man behind the gun at the forts. Their range of vision is restricted and for thorough work they must be used in conjunction with the aeroplanes. The balloon is useful for observing the splashes and indicating the correction of range.

With such a mobile system of armament, the aeroplane as a spotting machine fits in to perfection. Particularly is this true on account of the fact that it solves the question of location of aerodromes and the problems of Winter operations.

PROBLEMS OF WINTER FLYING SOLVED

The problems of Winter flying have been solved in the past two years by American aviators at Mineola, Canadian aviators in Canada, and Allied aviators on the various fronts.

The main factors in successful Winter flying have been defined by Henry Woodhouse, the author of the Textbook of Military Aeronautics, who has followed closely the progress of this phase of aeronautics, as follows:

(1) Clearing places on the ground for starting and landing; and placing on the snow, direction arrows of black canvas (which are supplied by Joseph A. Steinmetz, of Philadelphia), to give the landing and wind directions to aviators.

(2) Equipping the aeroplanes with skids for landing on ice or frozen snow.

(3) Using anti-freezing solutions of water, alcohol and glycerine and lighter oils for lubrication.

(4) Protecting the aviator from cold with warm clothing, electrically heated when the cold is excessive, and having arrangement whereby the exhaust can be used for heating the pilot and observer and gunner's compartments.

As Mr. Woodhouse points out, skids were used in the early aeroplanes by the Wright Brothers and Glenn H. Curtiss, J. A. D. McCurdy and other pioneers long before wheels were used. The earliest experiments at flying by Curtiss, McCurdy, Selfridge and Baldwin, in Baddeck, Nova Scotia, were made on ice.

The Limitations of Seaplanes for Coast Defense Work

The conditions in a Northern latitude are such as to practically prohibit the operation of seaplanes for coast defense. For instance, last Winter along the New England coast the weather was of such extreme severity that all the stretches of water were frozen which were sheltered enough to allow a seaplane to "get off" from this medium. In the more open waters where the ice does not form, the winds create such waves that it would be impossible for the average machine to get off or make a landing. I believe that for coast artillery work seaplanes are out of the question for use in any latitudes where severe winters are experienced.

Aerodromes for Land Aeroplanes Can Be Established Within A Radius of Twenty Miles of Forts

In the immediate vicinity of coast defenses, especially if they are located on islands, it might be extremely difficult to find suitable landing places for the land type of machine; but since the aeroplane is capable of such high speed there is not much difficulty in placing the aerodrome at a distance of up to 20 miles from the coast defense positions. From these positions the planes can be called to co-operate with the artillery within a few minutes from the time when they are signalled. However, it is a well recognized principle that coast defenses must be protected from the land side as well as from the sea, that is, they must be self-sufficient units independent in their protection. Therefore, with the old type of coast defense, if the aerodromes were located at a distance of 20 miles from the fortifications, they might be subject to capture by the enemy. However, with the introduction of the mobile type of armament, coast defense assumes an entirely different aspect. Coast artillery will move on railroad tracks over long distances, and the protection of these railroads will be in the hands of the regular field army. Thus a close co-operation will naturally result between the coast artillery and its personnel and the personnel of our regular field armies. With such a system we could safely assume that our aerodromes would be well protected since they would be guarded by our field armies. The instant that we are enabled to situate the aerodrome at a distance of 20 miles from the position of the fortifications we find that we have an enormous stretch of territory upon which to choose our landing sites. Let us suppose that the coast line is straight. We will draw a circle with a radius of twenty miles whose center is at the position of a coast fortification. The coast line will bisect the circles so drawn. Half the area will be water area and the other half will be land area, in which we can find suitable positions for the aerodrome. We will thus have approximately 628 square miles in which to choose a suitable position. It is certain that we should find some ideal location in such a large territory.

Twin Motored Aeroplanes Best for Coast Defense Work

In using land machines for the purpose of co-operation with the coast artillery we would naturally choose twin engine aeroplanes which would be capable of returning to their base on one engine should the other fail. The chances of loss through forced landing at sea would therefore be reduced to a minimum, and in fact, would not be more serious than the risks which are being run every day in the present war when the Allied aeroplanes travel for hundreds of miles over German territory. Under conditions of heavy snowfall only a limited portion of the landing field would have to be kept clear by means of motor-ploughs in order to facilitate getting off and landing. If this were impossible we could adopt the methods which the Russians have successfully employed of furnishing the running gear of the machines with skids which would allow them to get "off" of the surface of the snow and to land thereon.

Looking Over the Enemy's Smoke Screen

Once the problem of handling the aeroplanes in connection with the coast defenses is solved, a vast field of utility will be found for this weapon. In connection with coast defense work probably the primary importance of the aeroplane will be in connection with its use as a spotting machine to direct artillery fire. It will be particularly useful in this connection when the enemy fleet has produced a smoke screen which, under favorable conditions of wind, will entirely hide them from the coast artillery batteries. In this case the spotting aeroplanes stationed far above the smoke screen could direct the coast artillery batteries by methods employed in indirect fire so that they could inflict damage on the enemy vessels lying in plotted positions. This is a most important advantage, as it was only a few years ago that in the joint manoeuvres a division of our battle fleet succeeded in making a run-by at Fisher's Island by employment of the smoke screen.

Another most important function is that of the machines, scouting or reconnaissance. This type of plane would be used to observe the disposition of the enemy's naval forces, to observe any operations suggesting the landing of enemy troops; to observe the concentration of enemy units in preparing for a "run-by" or the forcing of an entrance; to observe the counter-mining operations of the enemy's small craft; to observe the operations of the enemy's mine layers. The information received from these observations would be of incalculable value not only to the personnel in charge of the coast defenses themselves but also to the commanding officers in charge of any of our naval units which might be operating along the coast.

For artillery spotting and scouting a machine resembling the Italian Sia type, which is capable of remaining in the air for ten hours and has a variation of speed of between 50 and 140 miles an hour, would be ideal. But another type of machine is necessary to carry on offensive operations with bombs and a heavy type of gun against landing parties, mine sweepers, and to harass the enemy in any way possible in the operations against the coast defenses. These machines should also be accompanied by a special fighting type of light machine whose duty it would be to overwhelm the spotting aeroplanes employed by the enemy fleet and observing the effect of its artillery fire against the coast fortifications. These planes would also prohibit the bombing operations on any of our coast towns by forces of enemy aeroplanes launched from the sea. There should be an absolute superiority of air force on the side of the coast defenses since with all the facilities which are available it should be possible for these defenses to put into the air five planes against the enemy's one, since the enemy has to transport them for thousands of miles and to handle them from a mother ship. This superiority in the air would give inestimable advantage to the coast defenses.

For Night Operations

Another duty of the aeroplanes serving with the coast defenses would be to warn our naval forces of mine fields laid by the enemy and to pilot them through dangerous areas. A special tactical function which might be employed with the use of aeroplanes would be for night work when specially equipped flying machines could drop high-power star shells over a bombarding or blocading squadron, illuminating these targets for the coast batteries without the necessity of the coast defenses using their searchlights and revealing their positions. It is to be hoped that strong pressure will be brought to bear in the development and organization of this invaluable asset for the protection of our coast line.

—*Flying.*

Liaison

By A. G. C.

If the general staff ever entertained any doubts about the relative mobility of 6″ howitzers and the field artillery pieces, these must have been set at rest by the extraordinary achievements of the former throughout the first week of the enemy offensive which started on March 21st. It is true that horse and field artillery batteries can occupy positions inaccessible to a mechanically drawn battery but it is rarely that the condition of the roads imposes any penalising limitations upon the choice of a position for medium howitzers, or jeopardises their effectiveness. In moving battles the 6″ how. can usually be fired from just off a road. If the weather be fine platforms are unnecessary in fact it is better to do without them if the ground be comparatively hard. Mats under the wheels are quite sufficient to ensure easy "switching" and absence of "jumpiness."

During the retreat we trekked and halted alternately for seven days: hated the trekking after the first day and loved the halting. Halting promised the better alternative, firing and resting. Once only during that seven days were we allowed to indulge in a really big strafe. For five hours we were left to our own devices with plenty of ammunition, no communications rearward, and an advancing enemy in front. We made full use of the glorious opportunity, the gunners have never worked better and the guns rarely behaved so well. This was the only bright spot in a gloomy week. Firing after this was just an interlude between wearying and exasperating spells of travelling—the wrong way.

Arnold Bennett's dictum was justified. Sleep is merely a matter of tradition and habit. Hitherto we've spent far too long in indulgence of a habit that in any excess produces sluggishness of liver, mental ineptitude, and premature corpulency. Use is second nature and we got well into our stride with the second, getting no sleep at all for six days.

Gunners are not easily discouraged, particularly those that spent last year in Flanders, wallowing in mud and had spent the blissful three months since on the beautiful wooded slopes of the extended line. The change from the desolation of desolations to a sojourn in a country resembling God's own—their own land—had a grand effect upon their morale. During the retreat the strain upon their physical resources was enormous but never once did a shell go home without that sweet familiar "plonk." However tired they were they would invariably help any emigré with a clumsy load, much to the amusement of the onlookers at times for a crazy wheelbarrow needs some skilful handling.

Doubtless it was necessary but every retrograde step was a cruel disappointment. It was curiously interesting to note how the pugnasity of the race became more and more assertive, and found chagrined expression, during those days. "But honour came back as a King to Earth, and paid his subjects with a royal wage."

One glorious evening we heard a rumour that we should "advance" to help the French. By morning rumour had materialised into fact and just before noon we were in action at X---- Our men were manifestly delighted. It was a move forward and promised them some consistent firing.

We were put under the command of a French group commander, installed one of our own officers at his headquarters to act as our intermediary, and our senior battery commander—himself of French parentage—acted as liaison officer with the French Division. No time was lost—lines were run out immediately to the O.P. a battery car being used as cable wagon. We registered both batteries during the afternoon. The O.P. itself was one of those we dream about but rarely find. The opposing forces of infantry were in a broad valley between two ranges of wooded hills. At one time during the war the Boche had occupied our slope of the hill and his usual accessories to safety were provided. We wondered what strategy it was that caused such a precipitate retreat of his forces, so hasty and unpremediated that the usual marks of the Hun were conspicuously absent, villages and towns had been left untouched. On the opposite slopes a ruined chateau, crossroads, lone trees, tiny copses and our lately abandoned hutments provided us with excellent ranging points. On the plain where it widened to the south were three stranded aeroplanes—two allied and one Boche—which had crashed or made forced landings during the retreat. These proved fatally interesting to the enemy infantry. It may have been curiosity or it may have been the desire to salve the machines which brought parties of the enemy to the planes. In any case we had a moving target and made the most of the opportunity—there were some new records for the quarter-mile put up that day. A calibration shoot on the ruined chateau was critically observed by the French N.C.O.'s on O.P. duty to whom we were indebted for the loan of an excellant observation instrument, not the only item of their equipment we coveted. Before dusk a machine gun post was discovered in the chateau walls and the French troops in the neighbourhood of the O.P. were roused to some display of enthusiasm by the accuracy and volume of our fire—ten round salvos make a fair splash and must have been as disconcerting to the enemy as it was interesting to our allies. This was an appropriate finale to the days' work.

Our French Commander who had waited to gush until he was assured of our effectiveness was highly delighted with our opening demonstration and our expedition.

On our part we regarded it in the light of a privilege to get properly into action again: our gunners felt rewarded for their extraordinary exertions and displayed the keenness arising out of a new satisfaction. Nothing is so encouraging to them as the evidence of their own officers as to the efficacy of their fire: one O.K. sent down from the O.P. by a battery officer means more to them than ten O.K's given from an aeroplane —the former kind are rare enough to possess the charm of novelty and be the subject of elation: scepticism is born of lack of personal knowledge, faith with understanding.

That evening we sat down to dinner with appetites fitting our new won grace; we'd come into our own again and were duly thankful. Several calls for S.O.S. during the night added to our satisfaction; they spelt vigilance and resistance. Our two batteries, maintained a pleasant rivalry for the honor of getting off the first salvo in response to each call.

We were kept very busy the next day. The enemy in his enthusiasm, somewhat intoxicated by his successes dropped a good deal of his customary caution and rushed troops and material up in lorries over roads well under our observation. Innumerable living targets presented themselves to our view and an almost bewildering number of them were engaged by rench 145's and 75's and by us.

Toward evening, having brought some of his own howitzers into position, the enemy attempted to neutralize a group of 75's and made himself generally unpleasant on our roads. One of his 15 cm. batteries was spotted immediately and a French battery brought to bear upon it, after we had convinced our fellow observers that our map was a representation of the same country as their own map purported to represent. They semed rather dubious until the first neutralizing round fell well into the Boche when mutual confidence was at once restored.

Our O.P. was fairly obvious though security was afforded by the fact that its limits were not narrowly prescribed. The Boche, pursuing his well-defined policy of intimidation, immediately replied to our neutralization by shelling our vantage ground with another battery. He continued to display the same peevishness and antipathy to our peeping until we bade farewell to the place. The French observers regarded his shelling in the light of a compliment and were not in the least perturbed: a very substantial Boche reinforced concrete structure was partly responsible for our mental equilibrium.

The last day we were in action at X---- we fired practically continuously throughout the day until 11 p.m. and engaged a surprising number of targets. Refreshed by two nights sleep our men worked particularly well, the signallers splendidly. The latter had a very 'sticky' time on the last day the Boche having taken a violent dislike to the road.

It is interesting to record that no gun went out of action throughout the three days we were with the French. This was the more remarkable after seven days jolting over all sorts of roads and seven days firing from many more positions.

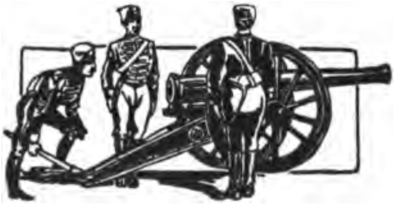
The last day at the O.P. was more than exciting but the most interesting of all. During this day the enemy made four distinct local infantry attacks, all of which were observed by us and all completely demoralised by the allied fire. The greatest enthusiasm prevailed in the vicinity of the O.P. as there were many French infantry officers near in addition to the French Observers—all N.C.O's. So useful had we proved ourselves that the French paid us the compliment of providing us with one of their coveted observation of fire instruments. We wished we could have borrowed it indefinitly the field of view was wide and the definition remarkable. Both in weapons and optical instruments the French seem to be ahead of us. Their heavy howitzers are drawn by F.W.Ds.

and are wonderfully mobile, much of their mobility being due to the excellence of the gun mounting and their rubber-tired wheels. The French too spare their horses in every way. Their field guns and field howitzers accomplish the major portion of their journeys on specially constructed lorries or trucks on the railways: their horses obviously inferior to ours suffer far less from exhaustion in consequence.

Our men profited considerably by their short spell of fighting with the French. Much of their self-complacency vanished. They seemed astonished at the Frenchman's capacity for work and his adaptability to his circumstances and environment. They noted with just a touch of envy the responsibility rested in the French gunner N.C.O. and I think that with a little more encouragement our N.C.O's might be more trusted with great advantage to our artillery. We trust them now but only more or less on sufferance, or as a stop gap when "needs-must."

It is with genuine regret that our batteries withdrew to the rest area for re-fitting. Before we left we were paid the handsomest compliments by our group and divisional commanders, both of whom seemed really grateful for the assistance we had given them during a somewhat trying time. Our parting with the French observers was eloquent testimony to the efficacy of our fire and our ready responsiveness to the many calls made upon us from time to time.

The establishment of the unity of the allied command under their own general was hailed with delight and possibly accounted for some of the expansiveness of their expressions of gratitude. On our part we were surprised at the smothness with which their artillery machine is worked, and the attention paid to the smallest details of battery organization—above all, at the smallness of the staff which promotes such efficiency. —*The Journal of the Royal Artillery.*



PROFESSIONAL NOTES

Automotives in the Great War

By Coker F. Clarkson

(General Manager of the Society of Automotive Engineers)

"Of those who are now pressing forward and contributing their services for the purpose of accomplishing the ending of the war, none have given greater or more patriotic service than this body of highly trained, highly educated, and high-minded motor-truck specialists." Thus spoke the officer in charge of the transportation division of the Quartermaster Department, of the work of members of the Society of Automotive Engineers on standardized designs of United States war truck. During the year 1916 this officer had maintained close relations with the Society of Automotive Engineers, and in conjunction with a committee of the Society prepared a draft of military truck specifications for the department. The Truck Standards Division of the S.A.E. entered earnestly into cooperation with the quartermaster department and representatives of other Bureaus of the War Department, with a view to providing suitable specifications for military trucks. The Society called officials of the National Automobile Chamber of Commerce into conference, and asked representative truck manufacturing companies to send their chief engineers to a meeting to consider the military truck needs of the Government. This resulted in the holding of a convention of fifty or more engineers and others. The action taken was to appoint a committee which later became the Truck Standards Division of the S.A.E., constituted of engineers of five companies manufacturing trucks, five companies assembling trucks, the engineer of a truck factory not making the type of truck being deliberated upon, and the truck engineer of the Quartermaster General's office. After joint meetings of this committee with the War Department Motor Transport Board, a revised set of military truck specifications was issued last April.

Later a conference was held of engineers of companies engaged in the production of various units entering into the construction of the trucks, including the engine, transmission, axles, springs, universal joints, frame, radiator and fan. The purpose was not to modify the War Department's specifications but to bring about such interpretation of them as would result in the production of parts, as well as complete trucks, in sufficient number to supply the Army adequately with trucks of proper type, the assembly units to be interchangeable so far as possible; and to a limited extent the parts of units of different make were to be interchangeable. The manner in which truck and parts manufacturers cooperated in this work was most gratifying and afforded additional manifestation of patriotism in a matter of vital importance in military operations.

In July the Government announced that it had decided as a matter of military exigency to standardize complete designs of war trucks, practically all the component parts thereof being interchangeable although made at widely scattered points. Committees, constituted in very large part of members of the Society of Automotive Engineers, were put to work promptly. Early in October samples of the U. S. Heavy-duty War Truck (Class B, rated by the Government at 3 tons, but of practically 5 tons Commercial capacity) were on the road, several samples of the U. S. Medium-duty War Truck (Class A, Government rated 1-1/2 tons, but substantially a 2-ton commercial truck) have been in operation for some weeks, and by the middle of this month samples of the Light-duty war Truck (Class AA, 3/4-ton will be under test. These models are new, especially designed from the ground up in almost every respect. The detail and broadest experience of the best specialists and experts has been availed of, and the trucks will meet most exacting requirements of war conditions. It will be possible to produce them in as large quantities as needed. The stock of spare parts necessary to send to the theatres of operation has been decreased enormously, simplifying very greatly the maintenance processes which have been distracting to the armies of our allies, who have been obliged to use trucks of many different designs and makes.

In designing the U. S. war trucks the engineers have naturally followed closely the experience gained by the Allies, as well as that had on the Mexican border by our manufacturers and Army officers. They have put at the command of the Government the best products of their brains.

The public does not appreciate fully the value of the scientific and technical organizations back of the factory engineers. While all automotive engineeers are competitors in a selling way, a close and confidential scientific basis underlies their work as a group and individually. Obviously this has had a commercial effect on the motor car, the motor truck, the motor boat, the airplane, the farm tractor and ather automotive products. It has much to do with progress toward ideals sought by all thorough engineers.

A great part of the efficiency of the motor car and of the motor truck of today is due to the splendid manner in which the proceedings of the Society of Automotive Engineers have been conducted by its members. If each of the manufacturers had worked solely on the knowledge of the engineers employed by him, we would not yet have seen cars of such perfection as has been attained, or cars sold at the relatively very low prices of today. In a word, the enormous and spectacular growth of the automobile industry and the wide use of cars are more the result of technical organization of engineers and builders than of any other one feature of the industry.

The non-technical mind does not really appreciate the vital inportance of standardization. To the average layman "standardization" frequently means that each and every car has an engine, clutch, transmission, frame, springs and axles of approximately the same general or identical makeup. Fundamentally in the commercial sense it is none of these big units that causes trouble to the automobile engineer or builder, or needs of standardizing. The comparatively small things, different merely because they are different and for no good reason, are the things that keep purchasing departments in hot water, delay production and increase cost; not to speak of delayed and increased work of designers.

The tube mills reported to an S. A. E. investigating committee some years ago that not less than sixteen hundred different sizes of tubeing were being called for by the motor-car trade. Few, if any, standard sizes could be stocked because of the minute though inmaterial difference in the specifications of each individual case. Before commercial standardization was established by the Society of Automotive Engineers, there were innumerable special dies, gages and jigs. Over six hundred distinct lock washer designs were specified between the bolt sizes of 5/16 and 5/8 inch, whereas three dozen were more than sufficient. Metals and metal alloys of every conceivable analysis were being ordered.

These are merely surface examples indicating how the lack of standardization complicated engineering, purchasing and manufacturing problems, to say nothing of the enormously increased cost of the finished product, due to lack of uniform manufacturing limits and patterns.

The Liberty airplane engine and the War Trucks are not examples of standardization in the commercial sense, but of military designs dictated by war needs. The standardization by the Government of the necessary designs of all kinds of self-propelled vehicles operable on land, sea or in the air, is one of the chief factors in determining the outcome of the great war. A very large number of war emergency machines are now being manufactured after designs submitted by automotive engineers working in cooperation with army officers. The term "automotive" includes the automobile, aeronautic, tractor, motorcycle, marine and stationary gas engine fields—in fact every type of self-propelled vehicle. The design, production, operation and upkeep of these classes of apparatus are of the utmost importance in time of peace. During a period of war the problems become multiplied many times because of their magnitude and the pressing importance of speed in their solution.

In the last analysis war as fought today is substantially the matching of great engineering enterprises. In the long run the side with the best engineering genius (including productive and organizing ability) will win the contest. The ramifications of engineering accomplishments are infinite. They include the automotive, mechanical, civil, mining, electrical, chemical, sanitary, marine and railway fields, not to mention others of scarcely less importance. All these are interrelated and interdependent.

The organization of the motor transport service required by modern armies is a problem worthy of the best engineering talent, and one in which the automotive engineer has done splendid work. The unusually severe service conditions make the problems to be met in keeping a fleet of army trucks in operation far more serious than those encountered in normal peace service. As a result of years of preparation and experience of the S.A.E. along standardization lines, the Government now has in production War Trucks which are not only rugged and finished as designs, but capable of being produced rapidly, and simple and easy to repair, the parts being made with a view to easy renewal, and absolute interchangeability. For many years the Society has been carrying on an extensive program of standardization. In every possible case the standards created by the Society have been made use of in the design of these War Trucks, what is quite as important is the fact that an S.A.E. organization accustomed to producing standardization work was in existence and proceeding smoothly.

The work of the Society members has not by any means ended with the completion of the designs. The Government organizations in which such matters as the production, inspection and operation of automotive apparatus will be handled, are made up largely of automotive engineers, a surprising percentage of whom are members of the S.A.E. who have entered the Service. The Engineer Corps will use a large number of trucks for the handling of materials. These will be for the most part probably of the types designed by the Quartermaster Corps in cooperation with members of the S.A.E. Light, high-speed trucks to act as airplane tenders will be employed by the Signal Corps. The medical department will use the same chassis, the Class AA 3/4 ton truck designed by the Quartermaster Corps organization. The Marine Corps and the Navy Department also will use this truck in considerable number. Incidentally, it will be put into service in quantity in this country by the Post Office Department. The first Government-owned motor vehicle postal service was established in Washington in October of 1914. This service has been extended to Boston, Buffalo, Chicago, Detroit, Indianapolis, Nashville, Philadelphia, Pittsburgh and St. Louis, and according to schedule was to supersede contract service in Brooklyn and New York the first of this year. As an indication of the efficiency of this service, it can be stated that in one of the cities where it was in operation during one year, the motor trucks engaged in the transportation of mail between the depot and the post office were scheduled to make 384,526 trips, and there were only 132 failures, or one failure to every 2,913 trips. Government-owned motor vehicle service will be extended as fast as conditions permit. Experience has demonstrated, the Postmaster General reports, that trucks of the same size should be of a single type for the reason that when different kinds of trucks are used, it is necessary to keep in stock repair parts for each type. When chauffeurs are compelled to familiarize themselves with the operation of trucks of different kinds they render less efficient service than where they are required to learn to operate a truck of a single type. It is therefore argued that the department should adopt a standard truck for use throughout the service. This can be accomplished in either of two ways: First, by adopting one of the standard makes of truck best suited to the needs of the service, or, second, by adopting a Government design of truck. The first plan is not believed advisable because it would give one company a monoply of the business and stifle competition. For that reason it is thought by the department that the second plan should be followed:

The operation of motor routes not only represents a more economical form of mail service to the rual communities, but also permits of the establishment of a wider postal zone from the larger and more important trading and postal centers. This means a better supervision of the service and the extension of the local zone rate on parcel post from the larger towns to a vastly greater number of families, giving them improved facilities for trading and at the same time increasing the utility of the parcel-post feature of postal activity. These are considerations that demand the most careful attention in these times of excesive costs for foodstuffs and other necessaries of life.

A considerable number of contracts have been awarded requiring the use of motor vehicles in the transportation of mails in the star route service, resulting in material reductions in schedule running time. By this means mail is not only delivered to a large number of post offices of considerable importance located on branch lines of railroad where trains do not arrive early in the day, or at points more or less remote from the railroad, considerably earlier than would otherwise be possible, but where rural delivery routes emanate from such offices the expedited schedules on the star routes has had the effect of causing the mail from surrounding cities to be delivered on such rural delivery routes 24 or 48 hours earlier than formerly, with the equivalent advances in the dispatch of outgoing mail.

In the Ordnance Department the necessity for greater speed and tractive effort, as well as the increasing scarcity of horses, have made necessary extensive motorization of equipment. Accordingly another group of automotive engineers, S.A.E. members for the most part, familiar with the design of tractors, has been working on the problem. Heavy ordnance, which heretofore it would have been impracticable to move successfully, is now drawn over ground almost impassable otherwise than by means of this modern motive power. In addition to the tractors used by the Ordnance Department, a large number of four-wheel drive trucks are provided for the handling of ammunition. The accomplishments made possible by the use of the so-called tanks, form one of the most interesting chapters of the Great war. The troops of this country will be provided with equipment of this character second to none in use by the Allies. It may be noted with just pride that the work involved has been in the hands of competent automotive engineers, many of them being representative S.A.E. members.

The motorcycle as now used for war purposes is made in two and three-wheel vehicles for dispatch work and for transporting machine guns. Here again the Society has rendered effective assistance to the Government in the standardization of parts, the Secretary of war having delegated officers of the Quartermaster Corps to confer with a Society committee on problems relating to the development, standardization and use of the motorcycle. The work of the Society's committee on this subject compares favorably with that of other committees and individual members already mentioned.

The automotive engineers have had a most important part in the conduct of the Government aircraft program. It is well known that the development of the Liberty Engine is properly credited to engineers who are members of the Society of Automotive Engineers and whose work has been greatly facilitated by the present and past activities of the Socitey. Due credit must of course be given to the Allied Governments for data furnished to our engineers who designed the Liberty Engine, but it should not be forgotten that this engine is strictly an American product, having been designed for rapid production, standardization and interchangeability of parts, factors not realized to the same extent in other designs. The benefit which this will have in increasing the effectiveness of our fighting contingents at the front can scarcely be over-estimated. The aviation engine is of course a high-strung piece of apparatus, one that must develop great power with minimum weight. The engine operates under full load and at high temperature practically all the time, so that its depreciation is relatively rapid. This in turn greatly increases the service problem and new parts must be supplied frequently in order to keep the maximum number of machines in operation. Here again we realize the importance of standardization and the necessity for absolute interchangeability, factors long appreciated by automotive engineers and practiced especially in the automobile industry in this country. The Society is justly proud of the work its members have done in connection with the production, inspection and upkeep of aeronautic apparatus. There is no more important work that they can do. In addition, the possibilities for development in the aeronautic field following the war are almost unlimited. A careful study is being made in connection with the National Advisory Committee for Aeronautics looking to the developing of a practical type of airplane for carrying mails, and the details are being worked out for the establishment of a number of airplane routes between several of the commercial centers, to be put into operation as speedily as satisfactory machines can be obtained for the purpose.

The submarine problem may possibly be solved by the adoption of one of the designs of large seaplanes now being perfected. The development of such types of aircraft is rapidly progressing and its activities are expected to have an important bearing upon the outcome of the war. The flying-boat no longer is a matter of speculation. It has proved possible to build a machine with the seaworthy qualities of a small yacht and at the same time able to take the air, for the purpose of locating and destroying submarines. The seaplane is not however the only type of craft for marine use in attacking the submarine, developed by the automotive engineers. The so-called submarine chaser is another of their war products. The designs and construction of engines used in many of these submarine chasers constitute another of the problems that automotive engineers have handled with marked success. The production of the boats by standardized processes has been a very great achievement.

The development of small stationary or semi-portable units for the operation of the wireless set, the searchlight, pumps, isolated electric lighting plants and machine tools in portable repair shops, is another of the matters handled by automotive engineers. The machines mentioned perform highly important functions in the great military organizations of modern times and those responsible for their design and operation deserve equal credit with those who have contributed to the more spectacular forms of modern warfare.

The development and production of the farm tractor constitute a branch of automotive engineering of equal importance with that having to do with any direct military activities. The farm tractor is playing a tremendous part in the production of food. It is well recognized by all who have investigated the subject that the total production of food in this and other countries can be further increased enormously by the application of the farm tractor in many forms, small as well as large.

S.A.E. members are performing valuable service in the prosecution of the war in innumerable ways. In any branch of the service whether here or with our men in France, where automotive apparatus is made or used,—there will be found the automotive engineer striving to do his part, always willing to cooperate with his fellow men and always looking for more work to do.

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The Battle of the Marne

Translated from Hachette's "Historic résumée de la guerre". 1917

By Laura de Russy Berry

Having arrived at Chantilly in the early part of September, after the withdrawal of the French-English Army, von Klück hesitated to pursue his march direct upon Paris. In fact it would have been imprudent to strike the entrenched camp that General Galliéni had ordganized around the city and defended by a body of excellent troops under the command of General Maunoury. The attempt would have been perilous to a supreme degree while the back of the French Army was within a short distance,—perfectly intact, and with an unbroken line. A counter thrust from the French Army would mean complete disaster to the Germans. They, therefore, resolved to destroy if possible, and failing this, to disrupt the armies of General Joffre and scatter them in all directions, leaving on the south an open road to Paris. The movements of the Germans inclined toward the East, withdrawing from Paris. The change of direction began on the 3rd of September. On the 4th the Germans occupied the Marne, Lagny, Meaux, La Ferté-sous-Jouarre, Chateau Thierry and Epernay. On the evening of the 5th they had advanced still further. Their advance guards extended beyond Coulommiers in the direction of Provins. But in making a flank movement toward the camp entrenched around Paris, a gap was formed in the attacking column. Here Galliéni immediately launched the Army of Paris under Maunoury. It was the hour the Commanding General had waited for, had foreseen and had anticipated. At once he gave the command to halt. about face, and make preparations for the battle,—a series of simultaneous battles engaging two million men on a front of less than three hundred kilometers, (about 186.5 miles). The attack begun by Maunoury on the 5th continued for several days. He had the entire army of von Klück at a disadvantage, who seeing the danger that threated him, recrossed the Marne and turned back towards the north. Maunoury's men held their ground with heroic determination in the valley of the Ourcq during those three terrible days, the 6th, 7th and 8th of September. They were joined by the English under Marshall French, who had retaken Coulommiers, and had carried by assault the Pass of Petit-Morin. In passing from the West to the East we have, first Frenchet d'Esperey, who on the 8th was at Montmirail and Vauchamps; then Foch, who had before him the Prussian Guard; Langle de Cary who was on the Ornaine, on the heights of Vitry-le-Francois, and finally Sarrail supporting Verdun. The struggle took place almost on this very spot. But now it is no longer the Germans who execute the outflanking maneuver. In their turn they risk being outflanked, and at the same time are being turned back, on our left wing by Maunoury, and on our right by Sarrail. On the 9th of September they made a desperate effort to break our line in the center but instead, they were broken there themselves. On the morning of the 10th they were forced to retreat. They were completely routed during the 10th, 11th and 12th of September. Foch, by a daring blow, overthrew the Guard in the Marshes of Saint-Gond. Ten French victories interlocked each other. The line of the Marne was regained and other territory added. Compiègne, Soissons, Rheims and Chalons were evacuated in the confusion of flight. The French pursuit continued beyond the Aisne, were the Germans entrenched themselves in almost impregnable positions preparatory to an advance. However, they might even then have been chased to a finish, if the enthusiasm of our valiant troops could have been maintained, but they were totally exhausted from a whole week's fighting without having had any rest. You must remember that that same day (the 12th of September) was marked by the definite check of the assault which, since the 22nd of August had been carried forward steadily by the Germans under the very eyes of the Kaiser himself, against the Grand-Couronné de Nancy, which, by the way, was defended in a masterly manner by Castelman.

The victory of the Marne is one of the most memorable events in the history of the world. It saved France and the entire world from Prussian domination.

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The After Gun

By William Hunt

AN EARLY ESSAY AT CAMOUFLAGE

It was my first experience of "camouflage," and I must admit for some time it took me in completely.

I had shipped my mules and I had shipped my men. I had drawn hammocks for the one and forage for the other. There was a cheerful and contented sound of rattling mugs and plates from the troop deck, and a steady munching noise from the mule stalls. I had got rid of the naval transport officer and the military landing officer, each of whom had gone ashore thoroughly happy in the possession of endless nominal rolls and lists of animals and vehicles. My stable guards were told off for the night, and as the warm curtain of dusk came down upon the busy Mediterranean port, I went down to dinner with just that right sort of tired, hungry feeling which follows a good day's work.

My next-door neighbor at the mess-table was the First Officer, a hard-bitten old chap who had survived and apparently thrived upon incessant voyages to the West Coast of Africa, and who had proud and garrulous memories of an acquaintance with the redoubtable, original prototype of that engaging desperado Captain Kettle.

"Can you find me a guard for our gun on the poop, to be mounted day and night?" he asked me, after we had swapped a few yarns.

"Surely," I said; "but I am surprised to hear that you have managed to wrangle a gun out of the Admiralty"—for this was in 1915, when the question of arming merchantmen was still in the stage of suggestion, controversy, and newspaper correspondence only.

"You've heard of the 'mystery' ships, haven't you?" he said.

"One hears rumors, you know; but I'm blest if I know what they are."

"Well, I've got a 'mystery' gun, and I'll show it to you to-morrow. Have your guard ready to mount on the poop deck at 9:30 a.m."

"Right-oh," I said; and that was all I got out of the old bird that night.

Next morning, at 9:20 sharp, the N.C.O., whom I had appointed temporary ship's sergeant-major for the duration of the voyage, was on the boat deck with six men and a corporal.

Having inspected them and checked one or two details, I proceeded with them to the poop deck, where I found "the chief" awaiting me.

"Here's the gun," he said; and, behold, it was so—at least, as far as I could see. A long, grey, ugly looking muzzle protruding from what appeared to be a bullet-proof gun sheild.

"See how obediently she answers her helm," said 'the chief', slipping behind the gun-shields; and, as he spoke, she swung her whole length round with the gun-shield from port to starboard, and then back again, finally coming to rest aiming dead astern.

"That'll shake up Fritz and his tin fish some, I should think," I said; and I must admit I felt considerably cheered at the thought, for our probable course lay through what had already proved on one or two occasions to be happy hunting grounds for Boche submarines.

"Would you like to see her fired?" said the old man, his eyes glistening with pride, as he affectionately patted his murderous-looking acquisition.

"We're well clear of land now, and I can touch her off in half a jiffy; you'll get the best view of the effect from the boat deck."

So up to the boat deck I trotted. I saw him fiddle about with her, but, from up where I was, could not see exactly what he was doing, as by this time my guard had crowded curiously round the gun.

Suddenly there was a loud report, which struck me as being singularly different from that of any gun which I had ever heard fired before, and then, at what seemed to me a considerable distance astern, there was a big bang and a great flare, and then a heavy splash in the water.

"Magnificent," I said, as I rejoined the party on the poop; "that was quite a different shell from any I've struck, so far—on land, anyway."

I thought my men seemed rather amused at something; but all the First Officer said was; "She's pretty convenient to handle, too!" and, as he said it, he grasped hold of her firmly near the gun-shield, and with a bit of an effort, lifted both that and the gun clean off the mounting.

"Lord Almighty!" I gasped; for this was finer than any feat of any music-hall Hercules that I had ever seen.

"D'you understand, now?" he said.

"Damned if I do, except that either it's the lightest gun ever forged, or you are the strongest man who ever sacrificed a promising career on the halls!"

"Forged!" said the old villain. "This gun is simply a good stout spar, and nothing else; it's swung on a good stout tar-barrel for a mounting; and the gun-shield is made of good stout packing case wood, covered with canvas; the whole having been given three damned good licks o' grey paint."

"But the shell, man—the shell?" I cried. "You can't bluff me that that splendid shell was made by the carpenter, or even by the cook?"

"No," he said, "but you can get a surprising effect if you insert a brass rocket-stand into the end of a spar, and then fire a rocket out of it. I don't believe in taking any chances where we are going; and if Fritz pops up and sees this gun, I don't believe there'll be much need to fire a rocket; and even if there is, I don't think Fritz has got grit enough to wait up on top and watch for us to fire a second. Remember that you did'nt spot it for what it was, yourself, at once, and you'd have been still less likely to if you'd been living for some days in a thing like a bob cigar, with nothing except the bottom of the Mediterranean between your perjured soul and perdition. No, if the Admiralty don't give me a gun, I'll make one."

Well, there was no recognized science of camouflage in those days, but I think the old reprobate really might well consider himself one of the pioneers of the movement. Be that as it may, my gun crew certainly swore that one pearly dawn, as the sun was touching up the rocky crags of one of those islands with which Providence has so picturesquely strewn those seas, a periscope popped up a few fathoms astern of us, but did not stay around long admiring our gun. Anyhow, whether their story of the submarine be true or not my story of the gun is apostolic veracity itself; and the fact remains that we made our port; which was more than many good ships did in those days; and whether or not she be still protected by her home-made gun, one thing is certain, and that is that the good old ship is still afloat.

—*From Land and Water.*

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A Cross-Channel Flight

Recently a large British airplane brought nine passengers across the Channel.

At the appointed time the passengers were there, with a considerable amount of material which was quickly stowed away into the capacious interior of the machine. One by one the voyagers climbed aboard by means of a ladder and made themselves comfortable.

The engines were started and the machine left the ground, climbed upward in a few great circles, and struck northwest toward the gleaming Channel.

The passengers were enjoying their experience, and talked together about the various landmarks below. First came an old French town with massive radial fortifications of moat and rampart which made it look like a great starfish from above. Behind, like steel bars, lay the shining canals linking up the scattered towns and villages; and far away the glittering waters of the Channel and the beloved white cliffs and green fields of England.

The engines thundered on, and the machine forged steadily ahead with a very happy ship's company aboard. It was rather a windy day, and below them the travelers could see the surface of the water dotted with whitecaps, which made them realize the advantage of traveling through the smooth levels of the sky.

It seemed they had no sooner left the coastline than the English cliffs lay below them. Very soon they were able to recognize familiar towns and harbors. Beneath them a leave boat seemed to be stationary, so rapidly was it overhauled and left astern, though, in fact, it was tearing through the water, as its bow waves and wake showed.

Over the tail of the big airplane the French coast was disappearing fast into the haze, and soon the travelers had passed over the beaches of England and were flying over green hills and village spires. Twenty-five minutes earlier they had been looking down upon the fields of Pas de Calais.

Soon the noise of the engine died away and the machine began to glide downward in great circles to its destination. Fields and farms and woods and villages rushed up to meet the travelers. In a few minutes the nine had climbed out, one by one, to the ground, and the big machine was being cleared of its material cargo.

"It will be the only kind of Channel crossing for a good many after the war," said one passenger.

"Even when the train goes straight through from Charing Cross by the Channel Tunnel," said the pilot.

"Well, perhaps so. It's a good way."

—*From Air Service Journal of October* 3*d*, 1918.

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Guns of the "Queen Elizabeth"

THE 15-INCH PIECE THAT BOMBARDED GALLIOPOLI

Official announcement has been made by the British Government that, since 1914, the strength of the British Navy has been practically doubled. No particulars have been allowed to transpire as to the composition of this new fleet, but it is a pretty safe guess that the increase in strength is due mainly to the building and putting into commission the large number of battleships and battle-cruisers of the super-type.

At the commencement of the war Great Britain had a large preponderance of power over Germany, particularly in dreadnoughts; but since the whole war depended on the British fleet maintaining an unchallenged command of the sea, prudence demanded a sufficient increase in capital ships to offset any of those sudden disasters to which war on the high seas is always liable.

It is probable that, by this time, all the capital ships of the new program are completed and are either in commission or shortly will be so. Today, the resources of the British yards are being devoted, just as are those of the United States, to the construction of destroyers and other anti-submarine craft.

The latest capital ships of which the censor has permitted any information and photographs to be made public, are the five well-known ships of the "Queen Elizabeth" class. These ships mark a long step forward in that tendency to merge the best qualities of the battleship and the battle-cruiser in a single vessel. They are credited with a displacement of 27,500 tons, but with full equipment of fuel, stores, etc., their displacement is probably nearer 29,000 tons. The class takes its name from the "Queen Elizabeth;" the other four are the "Warspite" "Valiant," "Barham" and "Malaya."

The "Queen Elizabeth" is familiar to the public because of the part which she played in the Dardanelles campaign, when she engaged in a long-range, indirect-fire bombardment of the Turkish forts commanding the Straits.

The "Warspite," it will be remembered, got into difficulties when she was engaged with the ships of the German fleet in the Battle of Jutland. Her steering gear was jammed, and she circled in toward the German line and was for some time the target for the heavy gun fire of half a dozen German ships. She straightened out the difficulty and resumed her place in the line with surprisingly small damage. Although no particulars as to their armor have been made public, it is certain that these ships must be well covered. The survival of the "Warspite," is sufficient proof of that;

for the German fire was very accurate on that day. The "Queen Elizabeth" is reported to carry 13 inches of armor on the belt, turrets and barbettes.

The two notable features in the "Queen Elizabeth" are the armament and the speed. In these ships a new type of gun, the 15-inch, 40-caliber piece, first made its appearance. Eight of these are carried, four in two turrets forward and another four aft. The secondary battery consists of 16 six-inch guns, half a dozen anti-aircraft guns, and several 12-pounders. She has four submerged torpedo tubes, firing the 21-inch torpedo.

The "Queen Elizabeth" has a rated speed of 25 knots, which is remarkably high for a battleship—in fact, at the time these ships were built it practically placed them, so far as speed is concerned, in the battle-cruiser class. They are turbine-driven, and some of the ships, on trial, reached a speed of 26 knots and over. Their high speed stood them in good stead in the Battle of Jutland, but not quite good enough. Could they have made a knot or two more, they would have steamed in column with the British battle-cruisers, and, theoretically, Beatty would have wiped out the battle-cruiser squadron of the Germans.

The 15-inch gun is the most powerful piece afloat today in any of the world's navies; although it will be outclassed by the 45- and 50-caliber, 16-inch guns which are being built for our latest dreadnoughts. It is 50 feet in length, weighs 85 tons, and with a charge of 380 pounds of cordite it delivers its 1,920-pound shell with a muzzle velocity of 2360 feet per second and a muzzle energy of 83,500 tons.

It will be noted that the velocity, judged by our standards, is low; for our own naval 16-inch gun has been designed for a muzzle velocity of 2,800 foot-seconds. The lower velocity of the British guns was adopted largely with a view to preventing rapid erosion. High velocity means high pressure and consequent high temperature of the powder gases, and high temperature means rapid erosion. By lowering the velocity and increasing the weight of the shell, it is possible to obtain at given ranges equal penetration to that obtained by using a lighter shell with higher velocities. The British Cordite, because of its partial contents of nitroglycerin is a much hotter powder than our own all-nitrocellulose powder, and consequently we can obtain higher velocities without a corresponding increase of erosion.

It is understood that the British have built some 18-inch guns and have installed them on one or more of their latest capital ships. This piece, of course, exceeds anything built or now under construction. Its shell must weigh approximately three thousand pounds and its energy, even if moderate velocities are used, will be enormous. Whether this huge piece will be permanently adopted is yet to be determined. —*Scientific American.*

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The Channel Tunnel

At the Inter-Allied Parliamentary Commercial Conference, sitting at the Royal Gallery of the House of Lords, the Channel Tunnel was under discussion for the greater part of the session. Sir Arthur Fell, Chairman of the House of Commons Channel Tunnel Committee, said the proposed tunnel under the Straits of Dover had for its object the linking up of the entire railroad system of Great Britain with that of the Continent of Europe, and its effect would be tremendous. With regard to the commercial aspects, the effect of the sea voyage on the goods traffic between Great Britain, France and the Continent generally was probably even more serious than the effect on passenger travel. Goods from the Continent to this country had to be packed for a sea voyage, and the journey from Le Havre to Southhampton or London required substantially the same packing as for a voyage to New York or Australia, while the freight charges were often less to New York than across the Channel. Many of the best products could not stand the sea voyage from France, and other consignments were unable to bear the expense and delay of two transhipments. With regard to passenger traffic, they could not, even on an extremely conservative estimate, compute at less than 65 per cent the percentage of passengers who would take the tunnel in preference to the sea routes. At 10s. per head 1,560,000 passengers would yield receipts amounting to £780,000, to which must be added £78,000 for luggage, £40,000 for postal service, and £640,000 for goods traffic. To accommodate the great European express trains the diameter of the tunnel would be 18 ft. The "cover" would be 100 ft., thus protecting the tunnel against mines, and provision would be made, in case of emergency, to flood it with water for a length of a mile. Expresses would run direct from London to Paris in less than six hours, and could travel at intervals of not more than five or ten minutes. As soon as they had passed under the Channel these trains would be able to traverse France, Belgium, Holland, Italy, Germany, Austria and Turkey as far as Constantinople without change of gauge. A resolution suggesting to the Governments of France and Great Britain that the construction of the Channel Tunnel should be proceeded with as soon as possible, was seconded by M. Luiggi (Italy), supported by M. Honnorat (France) and carried unanimously.

—*Pages Engineering Weekly*

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Need of Military Courtesy

Brig. Gen. Robert K. Evans, U.S.A., commanding the Philippine Department, in general orders to his command regarding the observance of military courtesy, gives some very plain talk. He says:

"Owing to the present state of flux of the Army due to shifting and new personnel, it is incumbent on commanding officers of all degrees to carefully enforce all provisions of Army regulations and customs of the Service regarding military courtesy. Laxity in the observance of courtesies is indicative of poor discipline, and makes for a less smooth and efficient performance of duty.

"In bringing the observance of courtesies to the high standard demanded by military discipline, friendly counsel to junior officers will be the greatest factor. No officer should resent the advice of superiors as to social conduct and the observance of courtesies any more than he would resent having explained to him the manner of performance of some official duty of which he lacked knowledge. The efficient performance of official duties and due observance of courtesies go hand in hand to complete the high standard required of officers.

"One provision of Army Regulations which is often disregarded is that contained in paragraph 406, sub-paragraph 6, reading:

" 'As a rule juniors will give way to seniors, and at all times juniors will show deference to their seniors *and will not ignore their presence.*' * * *

"The most apparent violations of the spirit of this paragraph occur in clubs and other places where officers congregate socially, and in large social gatherings. Usually the circumstances are such that a formal salute is not appropriate. Where circumstances preclude the recognition of the presence of superiors by a military salute, common courtesy alone, were it not supported by Regulations, would demand some other action than totally ignoring the presence of superiors or simply staring at them. The ordinary amenities of social life prescribe another course in analogous cases, and inexperienced juniors whenever they find themselves wondering whether they should or should not introduce themselves to superiors or recognize their presence in some other way, will find almost invariably that the decision should be affirmative.

"It is not possible to lay down hard and fast rules to govern in such matters, but the following advice to a junior should be a sufficient guide.:

" 'In the presence of a superior if a salute is proper, make it; if circumstances are such that a military salute is not appropriate, use one of the usual forms of courteous salutation; and if not acquainted with the superior and it is possible without being discourteous, introduce yourself or get a mutual acquaintance to introduce you. Go out of your way to be courteous.'

"Wilfully ignoring the presence of a superior is a flagrant discourtesy of which no officer should be guilty. Superiors are invariably glad to make the acquaintance of juniors, and juniors should not be deterred by diffidence or indecision from comporting themselves as their gentlemanly instincts dictate they should. Juniors, in introducing themselves, should be careful to clearly pronounce their names, and state the organization to which they belong. Seniors in reciprocating should avoid indifference and show the juniors their courtesy is appreciated. Servility and courtesy are far apart, and the former is not desired. The obligation on the part of seniors to return the salutation in the form and manner prescribed is even more binding than that resting on juniors to make it—and failure to do so on their part is a more serious and culpable infraction of and injury to discipline and comradeship than when committed by juniors, who, at least may offer the excuse of youth and inexperience. Greetings should be full, free and frank recognition of gentleman by gentleman, conforming to military usage when appropriate; and juniors should not, if the least doubt exists, presume seniors remember them from a previous casual meeting, but should reintroduce themselves.—*Army and Navy Journal.*

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Medals and their origin.—It is natural enough that the whole question of medals should also be rather prominently before the public just now. There is little to add to what we have said on the subject on previous occasions, but a few words on the origin of medals may not be inapporpriate or uninteresting. It is commonly asserted that the war medal was instituted by Napoleon. This is not correct, though the reason for the belief is easy to trace, inasmuch as Napoleon was probably the first to recognize the value of a special "ribbon to stick on the breast." But the actual issue of medals for active service was of considerable earlier date. Mr. W. Augustus Steward, an undoubted authority on the subject, in his book "War Medals and their History," explains that the rout of the Spanish Armada in 1588 in all likelihood gave the incentive to good Queen Bess to commemorate the auspicious occasion by the issue of medals in gold and silver, and "we may reasonably assume that they were given for personal decoration to the leading officers engaged in the defeat of the Armada, or that the recipients thought that by wearing them they would show respect to the Queen, and thus established the custom of wearing medals presented by the Sovereign for war service." A specimen of these medals, with rings and chain for suspension, probably from the neck, is to be seen in the British Museum. To turn now to the land forces, it appears that to Charles I must be attributed the credit of having established medals for military prowess. That ill-fated monarch, under an order of the Court held at Oxford on May 18, 1643, instructed that medals were "to be delivered to wear on the breast of every man who shall be certified under the hands of their commander-in-chief to have done us faithful service in the forlorn hope." But the first campaign medal proper was the Dunbar medal for presentation to officers and men who "did this excellent service" and, to use the words of Oliver Cromwell, in "commemoration of that great mercie at Dunbar," where the Scots Royalists were defeated on September 3, 1650. These medals have "the unique distinction of being the first of which there is a reliable record, indicating that the common soldiery and the officers equally participated in the recepit of a military decoration for war service." But it was only at the beginning of the nineteenth century that the custom was really established of bestowing upon all soldiers, from field-marshall to drummer-boy, the same medal.—*United Service Gazette.*

BOOK REVIEWS

Law for the Soldier. By Lieutenant Leslie Childs, U. S. Infantry. Wisconsin: Geo. Banta Publishing Company, Menasha. 5½" x 4¼". 76 pp. Paper. Price $0.50.

In "Law for the Soldier" the author has extracted certain paragraphs of Army Regulations and together with the punitive Articles of War, reprinted the same under one cover. The work is one of compilation, but is in a form which may encourage study and investigation on the part of the soldier. Its disadvantage consists in the fact that the many changes taking place render recourse to Army Regulations and the Manual of Courts-Martial advisable in nearly every case.

A Short Account of Explosives. By Arthur Marshall. Pensylvania. P. Blackiston's Son & Company. 10" x 7½". 96 pp. 29 il. Cloth. Price $1.50.

The entire field of military explosives is covered in this book which, while avoiding too great detail in the chemistry of explosives, gives sufficient information concerning their manufacture and test. The varieties of smokeless powder and high explosives in use in different countries are discussed from a point of view of their manufacture and their respective advantages and disadvantages in use. Fuses, primers, and projectiles are discussed with reference to the various explosives used in them.

The data concerning French, British, and German shells, fuses, etc., makes the book particularly useful to the artillery officer at this time. The author has succeeded in bringing together within a small compass all that an officer should know concerning this most important phase of military science, and it has the added advantage that it does not require more than a superficial knowledge of chemistry for its complete understanding.

French for Soldiers. By A. F. Whittem and P. W. Long. Massachusetts. Harvard University Press. 6" x 4½". 130 pp. Cloth. Price, $0.75.

This manual, appearing much later than the many French-English phrase books, which made their appearance on the outbreak of war, is a well balanced attempt to teach the soldier a certain amount of French grammar, while at the same time imparting valuable information of military phrases, organization, and tactics. It is a book designed for the use of beginners, and while it is manifestly impossible to teach all of French grammar in 130 small pages, it includes most of the essentials. Its treatment of the difficult French verb is comparatively brief, but one can get along very well in conversation, in spite of omissions of various tenses, with the information contained on the subject in the manual.

The book compares most favorably with the other French manuals on the market, and is decidedly better than the majority.

Map Reading and Topograghical Sketching. By Edwin R. Stuart, Professor of drawing, U.S.M.A. West Point, New York: McGraw—Hill Book Company. 139 pp. 5¼" x 7¾". Price $1.00.

This work combines the best parts of several excellent publications previously issued.

There are 9 chapters, 90 pages, on Map Readings; 4 chapters, 40 pages, on Topographical Mapping; and 1 chapter, 9 pages, on Panoramic Sketching. While covering the subjects treated in a thorough, concise manner the text is stated so clearly and logically that these subjects which are sometimes difficult are made easy. In fact with this book anyone who wishes to become proficient in any of these subjects, and who will put in the study and labor required, should even become experts.

On account of its size and price this little book will be excellent in the instruction of non-commissioned officers and should be used in that connection by all organizations.

Perhaps if it had been a pocket size it could have been more easily carried into the field for reference to the pages of symbols.

While giving a very complete list of the contents of each chapter in the Table of Contents it is believed that a good index would have been of much value.

One of the best features is the including of problems in the text covering the various points treated. This drives the facts home in the best manner, but as this book will often be used without the aid of an instructor the answers to all problems might well have been included.

The pages on lettering will be of immense value in correcting one of the weakest points both in sketching and map making.

There is no other publication today which covers the scope of this book in such an excellent manner.

Military Hygiene and Sanitation-Second Edition. By Frank R. Keefer, M.D. Philadelphia: W. B. Saunders. 5½" x 8¼." 340pp. Profusely illustrated. 1918.

This text-book, prepared primarily for the instruction of cadets at the United States Military Academy, West Point, has been found to have a wider sphere of usefulness. It is suited to the requirements of officers and men of the Regular Army, the Navy, the National Guard, and the National Army, in organizations other than the Medical Department; also. of students at civil institutions having military courses, Red Cross units, Boy Scouts, and those having charge of camps (construction, mining, recreation, etc.)

Diseases are not discussed at length, for the reason that the book is not intended for students of medicine.

The chapter on Physical Training has been written by Major H. J. Koehler, U. S. Army, Director of Physical Training at the U. S. Military Academy, a well known expert on this subject.

In the discussion of "Alcohol and other Narcotics," the aim has been to enable the students to form an intelligent opinion upon the whole subject and especially to distinguish between nerve assertion and scientific evidence.

A glossary of the technical terms used is appended.

Vacuum Tubes in Wireless Communication. By E. E. Bucher, New York, Wireless Press. 6¼" x 9½". 174 pp. Profusely illustrated. Price, $1.75.

This book is a valuable addition to the works on Wireless Telegraphy. The author has tried to make everything clear by the use of simple but explicit diagrams and phrases.

It is essentially a book for self study, so simple that one who has had an elementary education in the elementary phases of Radio electricity can readily understand it, and yet thorough enough for the trained student to find it useful. With this book any earnest student can gain enough knowledge of the fundamentals of the vacuum tube and the various circuits with which it is used to enable him to understand how and why the tube works. and will enable him to get better efficiency from any continuous wave set that he may be handling. It will save time usually taken up wading through a mass of unnecessary material, as the author has taken up the various types of vacuum tubes with over 100 circuits for their practical use and gives only the fundamentals, and these are what is needed.

This volume will be found useful in the schools that are teaching continuous wave radio electricity. The book is strongly recommended to the Radio Electricians of the service, and all officers who read this article and who have Radio Electricians under their supervision should call the attention of the men.to this work.

Winning and Wearing Shoulder Straps. By Lieut.-Col. Charles F. Martin, U.S. Cavalry. New York.: The Macmillan Co., 4½" x 5¾". 105 pp, Price, $1.00.

A book written by an Army officer of experience in an endeavor to answer the question "What should I do in order to make good as an Army officer?"

It points out and analyzes the various elements that go to make up an efficient officer,—mental, moral, and physical; how to train the mind; how to apply the knowledge gained thereby; how to develop habits of precision and executive ability; how to put service before self; how to develop character so as to be a model and an inspiration to his subordinates; in short, how to develop the qualities of leadership demanded of an officer in an army composed of men with the temperament and racial characteristics of the soldiers of the U.S.A.

Machine Guns. By Majors Hatcher, Wilhelm, and Malony. Wisconsin: George Banta Publishing Company. 8" x 5¾". 343 pp. Profusely illustrated. 1918. Price, $2.50.

An excellent book for the specialist or for one particularly interested in Machine Guns or Machine Gun Work. The three main divisions of the book embrace Materiel, Practical handling of Machine Gun Fire, and Machine Gun Tactics. Each division of the subject is thoroughly and clearly covered and the narrative is amplified by the insertion of numerous diagrams and cuts. The book compares somewhat with Danford and Moretti's work on Field Artillery. However, as we said above it is of more use to the Machine Gun specialist than to the Artilleryman, especially in these hectic times when there is so much literature which it is vitally important for the latter to cover.

How to out-think your Opponent. By Prof. Al Williams. San Francisco: John J. Newbegin. 7" x 5". 78 pp. Profusely illustrated. 1918. Price, $1.00.

The book is a small volume of about fifty pages describing with the aid of numerous illustrations, various methods, or "T. N. Tactics," as the author calls them, by which the unarmed man in close-in fighting may disarm and overcome and armed opponent. The title is obviously misleading. In treatment the book is both badly arranged and obscurely expressed. The author moreover, both in his introduction and elsewhere, puts altogether too much importance on the value of his particular contribution to the science of hand-to-hand combat. In spite of its poor treatment and limited scope however, the book describes certain new methods, the knowledge of which would undoubtedly prove valuable in hand-to-hand fighting.

In a word, the book would be an addition of considerable suggestive value to the reference library of a physical instructor, but altogether unsuitable as a text for the beginner.

Offensive Fighting. By Major D. M. McRae, M.C. Pennsylvania: J. B. Lippincott Company. 6" x 4½". 196 pp. 19 il. 1918. Price, $2.00.

This book is very clear and extremely interesting and instructive. The chapter devoted to "Co-operation between Infantry and Artillery" should be read by all officers of these arms, and if allowed to "soak in" will save us the many trials which the British must have gone through to get such co-operation—An Artilleryman who reads this book through will get a very vivid picture of what the Infantry must do in trench warfare—Out of fairness to the men who are applying and receiving the cold steel in the first lines as well as to have an intelligent idea of how to help out, the Artilleryman should know something about mine craters, trench raids, patrols in No Mans Land, and the other essentials of trench life which Major McRae so clearly describes.

The book is published in a very convenient size and shape, which, in addition to its excellent contents, recommends it to the library of a soldier.

Leadership and Military Training. By Lieut.-Col. Lincoln C. Andrews, U. S. A. Philadelphia: J. B. Lippincott Company. 6¼" x 4½". 191 pp. 1918. Price, $1.00.

For many years a book of the type under consideration has been a decided want felt by officers and noncommissioned officers of the Regular Army. The subject of leadership and the general subjective side of military life has never been adequately covered in any publication, official or otherwise. Consequently, and especially at this time, Col. Andrews' book is most welcome.

It contains the philosophy of military life developed after years of rich experience by the author. It formulates in a readable and interesting manner the psychology of the science of soldering. It is safe to say that no one of the older officers of the Army can read it without gaining a great many ideas relative to this most important phase of his career. For the newer officer the book is simply invaluable and if read and thoroughly digested should result in greatly increasing an officer's ability to lead men, to handle them on the drill ground, or in battle.

Notes from the Front. By Major C. R. Yates. Wisconsin: Geo. Banta Publishing Company. 5¾″ x 4½″. 128 pp. Pro. illustrated. Cloth. 1918.

In this book are carefully outlined the duties of officers connected with artillery and infantry behind the line and at the front. Subjects which pertain to artillery and infantry such as discipline, sanitation, medical treatment, billeting, detection and treatment of German spies, enemy's ruses, disablement of material which is in danger of capture, care of rifles, etc., are carefully explained.

With reference to artillery the following subjects are discussed: choice of and concealment of positions and observation posts, value of lines of communication and means of keeping them in working order, notes on field defences with diagrams, etc.

Infantry subjects which are discussed are; extracts from rifle fire, diagrams of good and bad field fortifications, bayonet drill, etc.

In general this book may be considered an officer's handbook.

Attack. By Edward Liveing. Philadephpia: The Macmillan Company. 7¾″ x 5¼″. 114 pp. 1918. Price, $0.75.

In this brief and intimate account of a platoon's participation in an attack on a strong German position, its author, a British subaltern of an infantry regiment, has written a stirring description of the feelings and experiences passed through. The book is not intended to be a military study, but the soldier reader will appreciate and enjoy the psychology of an attack and the manner of its carrying out. Mr. John Masefield praises it in his introduction as "a simple and most vivid account of a modern battle. No better account has been written in England since the war began." The words of such a critic can be accepted without dispute.

Traveling Under Orders. By Major W. E. Dunn, N. A. New York: Harper Brothers. 6″ x 4½″. 80 pp. 1918. Price, $0.50.

While orders covering regulations for embarking and debarking are explicit and extensive, they will not completely cover the questions that arise relative to moving a command from the United States to France, nor the conditions peculiar and incident to service in a foreign country. With its many excellent suggestions, this little book can save many an officer from errors and difficulties in this great business of getting "Over there." It is written by an officer who has already been through, and bears the stamp of authoirty. Not a few of its features are somewhat trivial, and yet, for the inexperienced officer, great and meticulous detail may be a blessing, and the book should not be harshly criticised for this fault, if such it be. No one can read it without deriving some hints of value for the future journey.

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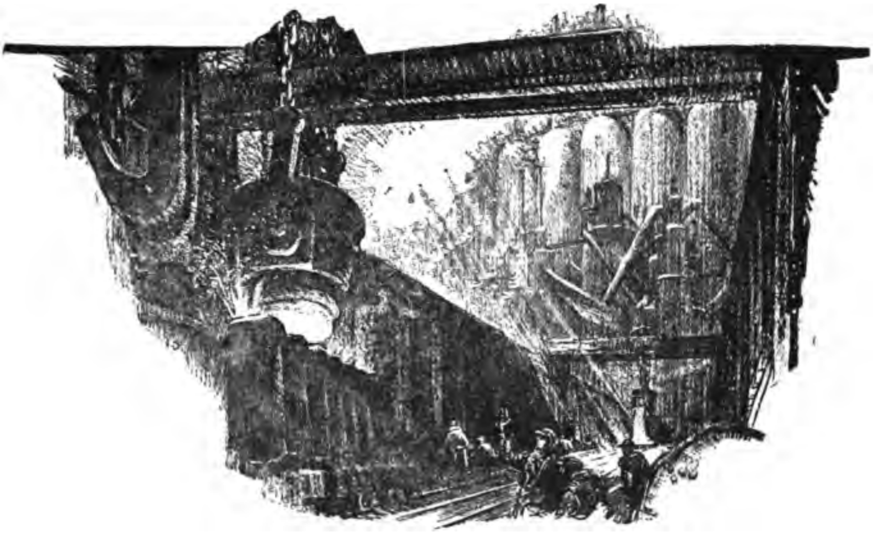

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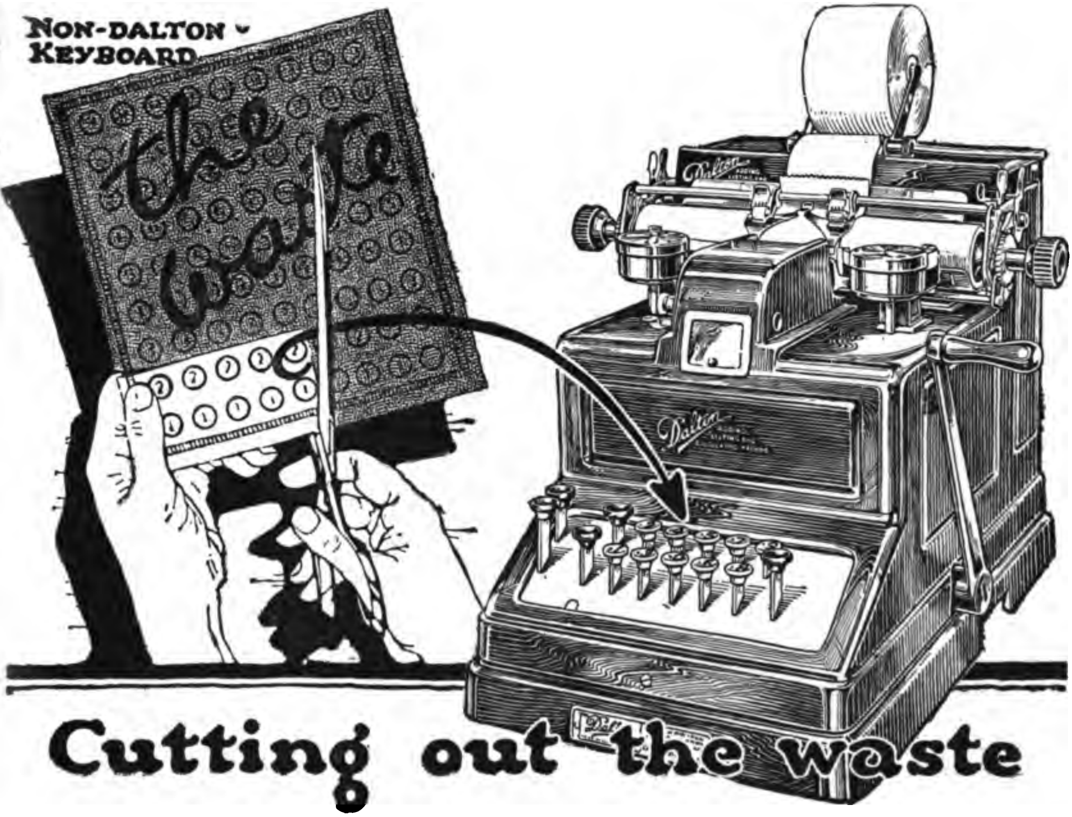

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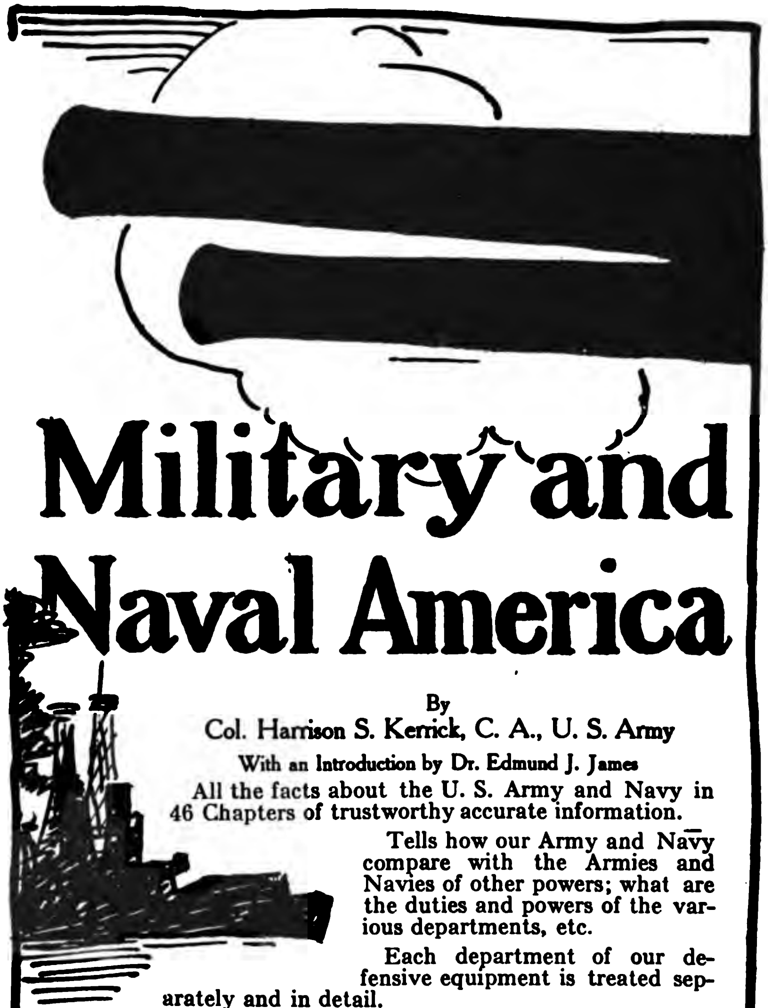

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